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Vol. XVIII. Parts I and II July, 1926

BIOMETRIKA

A JOURNAL FOR THE STATISTICAL STUDY OF BIOLOGICAL PROBLEMS

FOUNDED BY

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ISSUED BY THE BIOMETRIC LABORATORY
UNIVERSITY COLLEGE, LONDON
AND PRINTED AT THE
UNIVERSITY PRESS, CAMBRIDGE

Price Thirty Two Shillings net including postage

PRINTED IN GREAT BRITAIN

Issued August 14, 1926]

UNIVERSITY OF LONDON, UNIVERSITY COLLEGE

DEPARTMENT OF APPLIED STATISTICS

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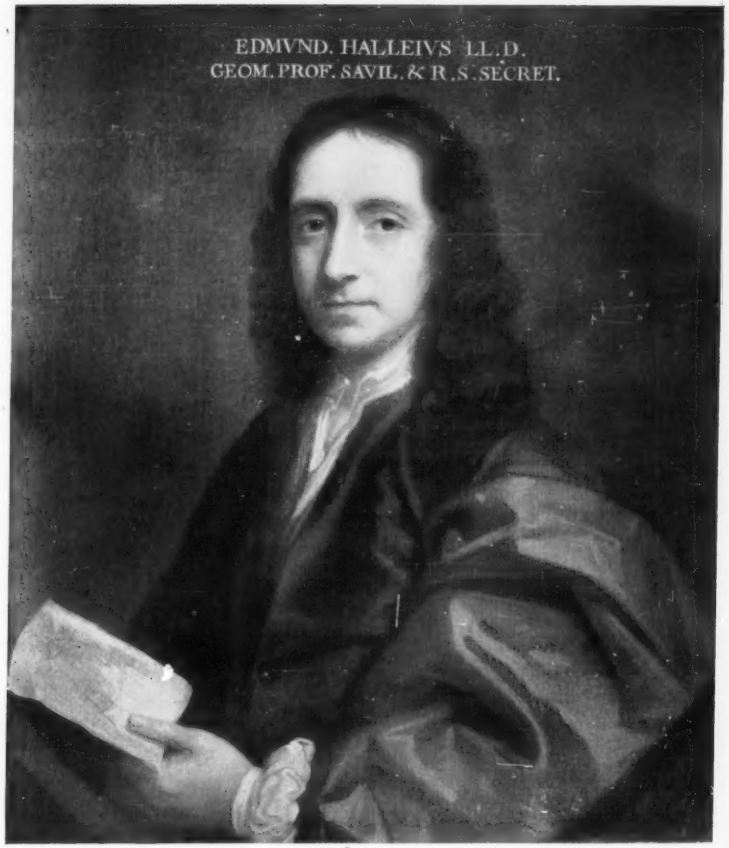

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VOLUME XVIII JULY, 1926 PARTS I AND II

BIOMETRIKA

A THIRD STUDY OF THE ENGLISH SKULL WITH SPECIAL REFERENCE TO THE FARRINGDON STREET CRANIA.

BY BEATRIX G. E. HOOKE, Crewdson-Benington Student in Craniometry, University College, London.

(1) *Account of Material and its Period**. The crania measured and discussed in the present paper were dug up during the removal of certain old houses at the corner of Stonecutter Street and Farringdon Street, and during the resulting excavations for the foundations of the new business premises of Messrs Gordon and Gotch erected on this site. The building operations were started in the spring of 1924 and the present buildings completed in 1925. The site excavated had a frontage of about 63′ on Stonecutter Street, and this part had a breadth of 23′; the total frontage on Farringdon Street had a length of 90′, or excluding the Stonecutter Street rectangle (63′ × 23′), a frontage of 67′, to which there was a breadth of 45′. We shall speak of these as the Stonecutter and Farringdon rectangles. Both rectangles were excavated to a level of 15′ below Farringdon Street. Roughly at 15′ gravel was reached and pits were driven 10′ lower, some 6′ through the gravel and 4′ through the blue clay for the stanchions for the new buildings. The west boundary of the Farringdon rectangle was formed by a nineteenth century wall going down 15′. The west end of the Stonecutter rectangle, extending 18′ to 19′ beyond the western boundary of the Farringdon rectangle, was the floor of a cellar of an 18th century house. The north and south boundaries of the Farringdon rectangle were formed by massive brick walls reaching to a depth of 15′, and a third such wall ran east and west across the Farringdon rectangle dividing it into two unequal rectangles, the north 37′ × 45′ and the south 30′ × 45′. These walls we are informed were certainly built before 1760. In the Stonecutter rectangle no human remains whatever were found. The whole of the Farringdon rectangle was densely packed with human remains to all levels from within 1′ of the surface of Farringdon Street, and they appeared to extend as a mass of osseous debris under Farringdon Street itself. There must have been more than 600 skeletons on the site, and they were clearly not deposited as buried. The graveyard had evidently been violently disturbed, and none of the workmen had come across a skeleton lying in such a position as that in which it might have

* Prepared by the Editor from data collected by G. M. Morant, B. G. E. Hooke and M. Child.

been interred. Fragments of wooden coffins, coffin handles, etc. were found, but in no case fragments of hair or tissues such as occur where coffins have not been broken up and disturbed. In fact the whole was a jumbled mass of human bones, rotten wood, building materials and earth. In many cases mortar or concrete was attached to the bones, showing that in earlier building operations, no respect whatever had been paid to the human remains; they had also largely been piled up against the northern boundary wall of the Farringdon Street rectangle.

A few human skeletons were found in the blue clay though far less plentifully, and at the same level bones of dogs, oxen and pigs, said to be indistinguishable from modern varieties. Except the staining these skeletons from the blue clay were not distinguishable from those found above, and it seems probable that the clay as well as the gravel had been disturbed.

The artifacts found included (*a*) fragments of tiles probably of 17th century, possibly of early 18th century, (*b*) an almost complete unornamented earthenware vessel about 2′ high (now in the London Museum), and the base of a precisely similar one. Mr G. F. Lawrence, Inspector of Excavations to the London Museum, dates these water pots as late 17th or early 18th century, (*c*) clay tobacco pipes, one of the Restoration period and the others 20 or 30 years later, (*d*) coffin handles, most of very simple form, giving no reliable clue to their age, but very possibly of 17th century date. *Three* coffin handles were ornamented, and said to be of Georgian date, "later than 1760." The supposed date of these handles is not in accordance with the bulk of evidence with regard to the interments. (*e*) Two very small and simple head-stones with initials and dates, 1665 and 1666, i.e. the years of the Great Plague and the Great Fire. These head-stones were found under the present pavement of Farringdon Street, under which, as we have noted, the osseous debris extends.

The absence of other domestic articles is noteworthy as the parish records show continual difficulties with the deposit of refuse in the graveyard. The shells of edible shellfish were in abundance at all levels down to the bottom of the cross-walls. Most of the bones were discoloured, according to the depth at which they were found, and some had the bluish green stains of copper salts*.

Such is the information collected on the site by Mr G. M. Morant, who spent several days watching the excavations. We must now turn to the chartographic history of the site. Here we have to bear in mind that originally a part of the present line of Farringdon Street was occupied by the Fleet River†, and that barges used to ascend this river to discharge coal. In 1307 we learn that 10 or 12 ships with merchandise could reach Fleet Bridge, while some of them would go up as far as Holburne Bridge. Even as late as 1502 we hear of vessels with fish and fuel being rowed to the Fleete and to the Holburne bridges. An effort in 1589 to preserve the navigation of the Fleete seems to have failed‡, and it

* Similar staining was also noticed in the Liverpool Street and Whitechapel finds.

† How few Londoners now turn a thought to the Fleet River, the Old Burn, the Wells Beck, the Long Burn, or the Wall Brooke, on which the old water supplies of the London district once depended!

‡ The volume of water was originally adequate to make mills in the Whitefriars area profitable.

became more filthy and decayed than ever. The tanners especially were accused of putting their refuse into it, and from this standpoint, it is of interest to note, that part of the modern Stonecutter Street was originally called "Curriers' Alley."

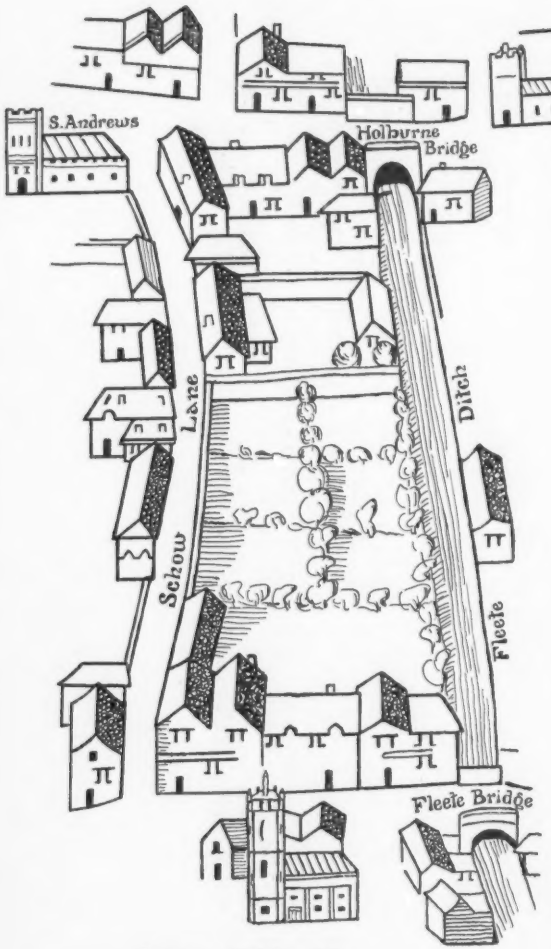
If we examine Agas' map 1560—70 (see Fig. 1) we find a rectanguloid area stretching between St Andrew's Church on the north and St Bride's Church on the south. It is bounded on the south by a row of houses facing Fleete Street, on the east by the Fleete Ditch running from Fleete Bridge to Holbarne Bridge, on the north by Holburne and on the west by Schow Lane, now Shoe Lane. While there are houses to the north and south of this area, the middle and southern portion is clearly garden ground with trees; there are no houses on the Fleete Ditch side, but a row of trees and the suggestion of a walk between the trees and the ditch. On the Schow Lane side is a wall with no house until we approach the Fleete Street end*. This space is still open ground in Norden's Map of 1593.

The home of the Sackvilles, Dorset House, in the Whitefriars, had originally been the town residence of the Bishops of Winchester, then it had passed on rental from the Abbot to the Bishops of Salisbury ("Salisbury Court†") and finally into the hands of the Sackvilles from the famous Bishop Jewel who alienated it to Sir Richard Sackville, the founder of the family, and father of the more famous Thomas Sackville, first Earl of Dorset, poet, courtier and statesman. He died in 1608 during a council meeting at Whitehall. His eldest son, Robert, enjoyed the Earldom only for a year, and was in turn succeeded by his elder son Richard (1609), least distinguished of the Sackvilles—except for his debts, and the gift which brings him into our notice here. The burial ground of St Bride's had become overcrowded, and extension was urgent. It was probably to preserve the amenities of Dorset House—there were then orchards between Saint Bride's and the Thames—that Richard Sackville, third Earl of Dorset, who had just had his manor of Salisbury Court confirmed to him by James I, gave a grant of land in the same year 1611 to the parish of St Bride‡ as an additional burial ground. This land was the garden ground between Schow Lane and the Fleete River as shown in Agas' map of 1560—70. The terms of the indenture dated 28th July 8th James I (1611) tell us that Richard, Earl of Dorset, bestows on the parishioners and inhabitants of St Bride's Parish, a piece of ground part of his manor of Holborn to be made, dedicated and employed to and for an addition to the churchyard and burial place of the parish; and also further granted and conveyed

* Agas' map corresponds fairly well with the copy in the Grace Collection of Van der Wyngerde's view of London. In the latter we see the Fleet stretching from the Fleet to the Holborn bridge, with a wall on the west side and barges. The garden ground seems bounded by a wall rather than by trees.

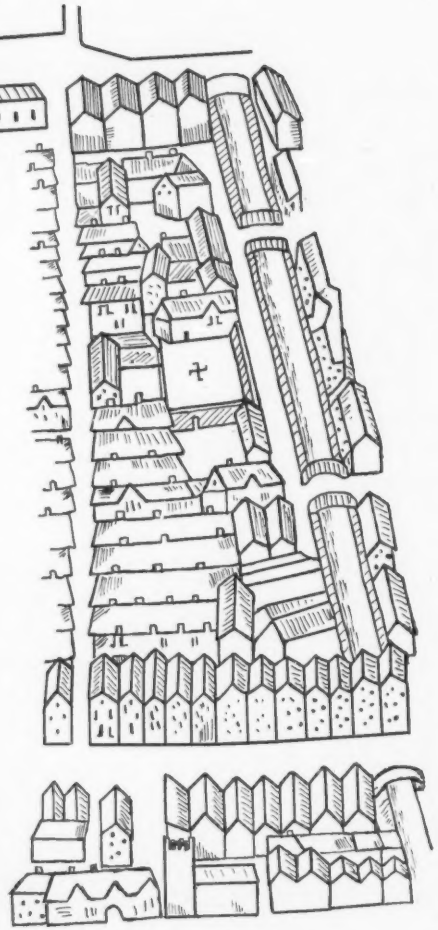
† "The next is Salisburie Court, a place so called for that it belonged to the Bishops of Salisburie, and was their inn, or London house, at such time as they were summoned to come to the parliament, or came for other business; it hath of late time been the dwelling first of Sir Richard Sackville, and now of Sir Thomas Sackville his son, Baron Buckhurst, Lord Treasurer, who hath lately enlarged it with stately buildings." Stowe's *Survey of London*, 1598. Edn. Dent, p. 353.

‡ According to Stowe the parish church of St Bride was of old time a very small thing, until William Venor, Esq., "Warden of the Fleet" about the year 1480, increased it with a large body and south aisles, probably to accommodate the needs of a rapidly growing parish outside the walls.



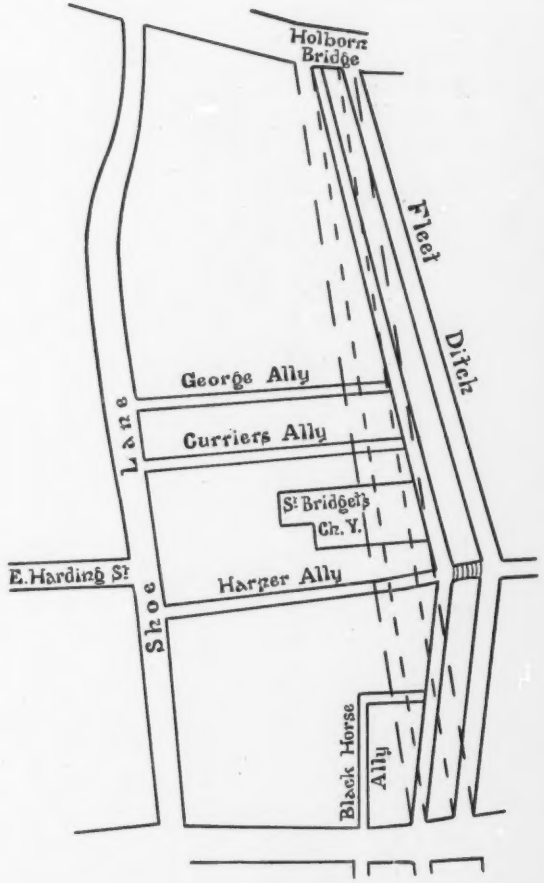
AGAS. 1560 – 70

Fig. 1.



NEWCOURT. 1658

Fig. 2.



– – – *Sheweth the enlargement of ye street ways etc.*

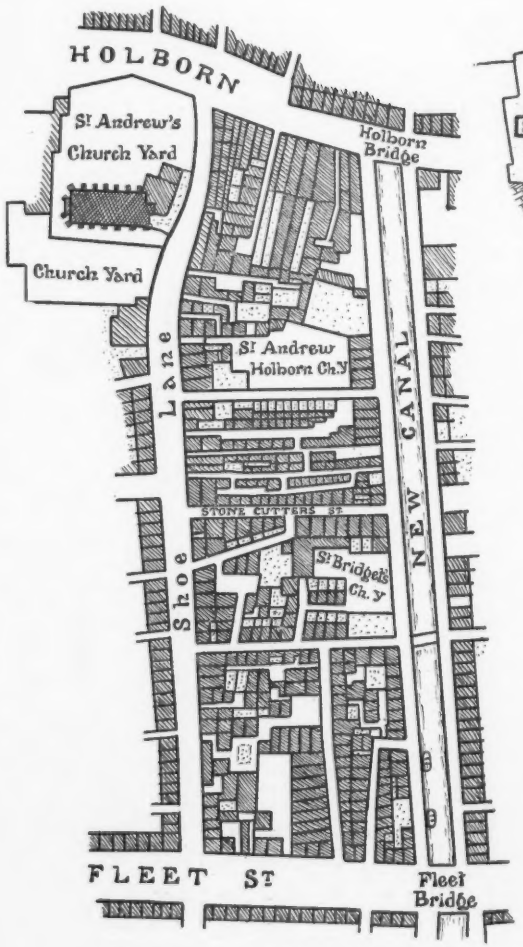
LEAKE. 1666

Fig. 3.

Fig. 1.

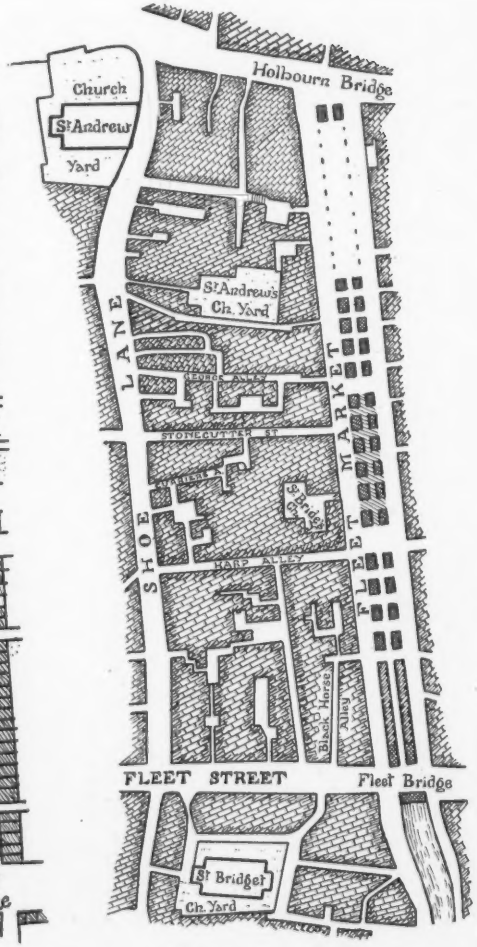
Fig. 2.

Fig. 3.



OGILBY & MORGAN. 1677

Fig. 4.



ROCQUE. 1746

Fig. 5.

ORDINANCE MAP

1916

Fig. 6.

to the Vicar and churchwardens for the time being and their successors certain parcels of garden ground to be converted, used, dedicated and employed to and for an enlargement of the burying places of the said parish and *to no other use whatsoever*, unless the said Earl of Dorset, his heirs and assigns or any other well-disposed person or persons should be willing to erect or build any houses or buildings on some part thereof for the relief of the poor of the said parish*.

It might naturally seem from this indenture that the Earl supposed a portion of the land might be devoted to the erection of almshouses, and the remainder to a burial ground; it can hardly be argued that he proposed that what might be used as a burial ground would *afterwards* be used as a building ground even if the rents were employed for charitable purposes.

Owing to the courtesy of the Vicar of St Bride's it was possible to make an examination of the Minute Books of the Vestry. The first Minute Book runs from 1654 to 1664. It is clear from this book that the "churchyard by the Ditch" or the "new churchyard" was already being used for purposes not contemplated by the donor. Thus in 1654 the Vestry had to order that "no souldiers† shalbe admitted to exercise in the new churchyard, nor any doores to be opened into ye churchyard without consent of the Vestrie" (April 4th). These doors into the churchyard were the source of perpetual trouble to the Vestry. They ordered the doors to be nailed up or they granted the door-intruders the privilege of their doors on payment of a yearly rent of 5*s.* if they agree to "doing nothing to prejudice the churchyard" (July 7). Again, June 26, 1657: "Ordered that all the doors, openinge into ye new churchyard, be stopt upp and that none be admitted to any privilege into ye said churchyard, but by the churchwarden's appointment, and that hee take care that nothinge be used there that shall annoy the churchyard or make it unhandsome." Further, August 2, 1660: "Ordered that the doors of ye new ch. yard by the ditchside be nailed or made upp speedilie it being a great annoyance to the ch. yard and not to have any liberty therein for private use for rent and the ch. wardens and constables are desired to see this order performed."

It is clear from these and other passages that houses were growing up on the open space round the churchyard, or even on the churchyard itself, and that the inhabitants of these houses were encroaching on the proper uses of the churchyard to carry on their trades or deposit their rubbish‡. It is not very easy

* *Endowed Charities* (*County of London*). *Parish of St Bride, Fleet Street*, 243, 1. 1901. Eyre and Spottiswoode, p. 15.

† In 1896 Mrs Basil Holmes writes in *The London Burial Grounds* (p. 319), Additional ground for St Bride's, Fleet Street:—"This is off Farringdon Street, is about 750 square yds. in extent and used as a volunteer drill ground. There are no tombstones and the ground is untidy." The absence of tombstones (as evidenced also in the excavations) was probably due to its being a burial ground for the poor.

‡ April 27, 1663, we meet again with complaints of "the dirt and rubbish constantly thrown into the said church yard, making it a great annoyance." Even a wall of the burial ground had fallen down and many of the bricks were stolen: the Vestry ordered the churchwardens "to viewe the said ch. yard wall and other annoyances and consider what should be done to remedy it."

to settle when the Vestry itself began to build *on* the churchyard. But it is evident that by 1659 the Parish had built houses *by* the new churchyard, for on June 22, 1659, the churchwardens are directed to inspect the houses in Harpe Alley, the *tenants* "complaining of the chimnies that are lately fallen downe and to enquire whose right (!) it is to repaire." It is from Harpe Alley that several of the doors were made into the churchyard. But it is clear that by April 3, 1656, the actual building *on* the churchyard has become a discussable proposition: "It was thought fitt that the churchwardens doe returne Mr Palmer, late minister of this place, thanks for his charitable thoughts towards the poore of this parish, and that it was the will of the Vestry, that if he would build houses for poore people of this parishe to live in that he should have such proportion of ground out of the churchyard by the ditchside to build upon as he should think fitt." This matter might seem to have been dropped for three years; for on July 13, 1659, we read: "It is thought fitt that the goodwill of Mr Palmer be hearkened to and be accepted of and some buildings be made as hee shall desire to raise a * towards ye relief of the Poore in consideration of it, alsoe some buildings to be made to joyne to it for the moneys given by Mrs Looman." Again on April 25, 1660, there is more consideration of Mrs Looman's gift, and "some parishioner of the parishe" is willing to advance "the same at present for ye building of some houses on ye ch. yard by the Ditchside for to raise £6 yearly benefitt to be paid for the use of ye poore for ever." Presumably Mrs Looman's gift was out at interest and could not be immediately recalled.

Now there are, I think, two schemes here, (*a*) that of Mr Palmer of 1656 to build almshouses for the poor of the parish, and (*b*) the scheme of 1659 to build houses at the cost of Mr Palmer and Mrs Looman to be rented and provide an annual sum for the poor of the parish. My reason for this is that we read on August 28, 1660: "Att this Vestrie it was taken into consideration that the six houses by the ditchside adjoyning to the churchyard were filled with poore people who neither pay rent nor keepe them in Repaire...ordered that they be all turned out and the overseers of the poore do take order for the putting them in Repaire and afterwards lettinge them."

These six houses are a mystery. Where did they stand? It would certainly appear from this that already in 1660 houses had been built "by the Ditchside," i.e. on the border of the churchyard facing the ditch. It is noteworthy that six messuages on the west side of Farringdon Street still belong to St Bride's Institute or Foundation, i.e. Nos. 75—80 inclusive. If these 1660 houses were first put up by Mr Palmer in 1656, it seems unlikely that they would be in bad repair by 1660. It appears more likely that they had been built on a portion of the churchyard before the date 1654 at which the Vestry Minute-Book starts. Such would be in accordance with the suggestion of the Earl of Dorset's grant. Yet in Newcourt's map of 1658 (see Fig. 2) although the churchyard† is built up with houses on

* Word illegible, but the sense is clear that the rental of the buildings was to provide an annual sum for poor relief.

† The space marked with a cross.

the north (one with a door into it), and on the west, there is still only a wall towards the Fleete. On the south towards Harpe Alley, however, there do not appear those houses with doors entering the churchyard, which are so constantly referred to in the minutes. There are houses facing the Ditch south of the churchyard, and possibly these are the houses occupied by the non-rent-paying poor which had fallen out of repair. In the Minute Book for October and November, 1660, the building on the churchyard is several times mentioned. Thus:

October 10*th.* Ordered to pay the bricklayers' bill "if possible."

October 23*rd and* 25*th.* "The former order concerning the bricks laid in the new churchyard for the building there was considered, which building the vestry supposed could not be performed in regard to the many corps that are found to be buryed there, and therefore they considered of another place for the building, of [a] place nominated in the south side of the old churchyard, and certain persons were ordered to review the ground and report their opinion touching it to the vestry."

"Mr Sampson made report concerning the building that it was the opinion of some that it could not be performed in that place neither [New churchyard?] without an order from the Bishop and Deane, and some were against building in the said churchyard in regard it was appointed for another use...many more desired the Vestry to consider again of the old churchyard and thereupon this vestry ordered to meet the next day at 3 precisely to view the ground in the chyard in order to build if it was convenient."

October 25*th.* "Again it was put to the vote when the building should be performed in the old c. yard, according as was mentioned in the former vestry, and by most hands it was agreed to. Whereupon Mr Read the carpenter was called in to be discoursed with about the doing thereof. But in regard to the Season of the year was not thought by some of the Vestry to be so convenient for it as the spring, it was by most hands agreed that it should be deferred till then, and it was debated how the Bricklayers and Carpenters bills should be paid, but nothing concluded concerning them."

November 2*nd.* "The charge incurred about the intended building to be defrayed and the workers paid...but where [? whether] the building should be forthwith or at spring was now again indespute." [Matter referred to a Committee.]

January 28*th*, 1660—61. Promised again to pay the carpenter and bricklayer.

April 24*th*, 1661. "Vestrie doth agree that the churchwardens shall lett a lease to John Fuller, Cutler of the house where Widdow Hillman dwelt by the New Churchyarde, Ditchside."

During the following years we find no reference to the building, but a house is purchased in Whitefriars with Mrs Looman's gift (1662—3). So that gift was not spent in building by the Ditchside.

June 15th, 1663. "Ordered that the old houses of the parish by the new churchyard much out of repair be speedily putt in repair to preserve them from being utterly ruinated."

July 8th, 1663. "That the two churchwardens doe take care for the speedy puttinge in repaire of the Parish Houses by the Lower churchyard* formerly ordered, but nothing done in it."

It cannot be argued from these minutes that actual building on the occupied churchyard took place between 1654 and 1664, although it was clearly proposed and bricks taken to the churchyard. At the same time it is clear that Parish Houses for the poor had been built on the land granted by the Earl of Dorset, and that these were already old and dilapidated.

But a new state of affairs was coming. In 1665 the plague broke out and on July 7, 1665, we read: "Part of ye churchyard by the Ditchside to be inclosed for the bearers to be in."

At the first onset of the plague St Bride's had relieved the necessity of the neighbouring parish of St Dunstan's in Fleet Street by allowing the use of the new churchyard for its dead and also lending its bearers. But as by August both churchyards were becoming *choked*, the Vestry appointed two persons, who should give orders for digging plague pits and pay the labourers. Before the plague ceased St Bride's had suffered as severely as any other parish†. We thus have definite evidence that before 1666 the new churchyard was choked. There is no need on account of the mass of skeletons recently exhumed to appeal to centuries later than the seventeenth!

Let us turn to what happened after the Great Fire in 1666. This is well illustrated in Leake's map of 1666, which "sheweth the enlargement of ye street ways, etc." (see Fig. 3). According to this scheme not only was the Fleet Ditch straightened, but its actual channel and the passages on either side of it were to be carried right across "St Bridget's Ch. Y." reducing the size of it by about a half. This would fully account for the osseous debris to be found under the pavement of Farringdon Street. That this change was carried out within ten years is evidenced by Ogilby and Morgan's Map of 1677 (see Fig. 4). Fleete Ditch now appears as the "New Canal." The distance along Shoe Lane between Curriers' Alley (Stonecutter Street) and Harper Alley is the same on the two maps, but St Bridget's Churchyard is reduced to about half its original extent; its decrease in dimensions east to west is precisely that indicated in Leake's plan‡ of reconstruction for 1666. Again while Newcourt and Leake show a straight northern boundary to the churchyard, Ogilby and Morgan indicate that after the reconstruction the yards of two houses in Stonecutter Lane encroached on the church-

* "Lower churchyard" here certainly means the New churchyard by the Ditch, but as farther from the Thames, one might easily suppose it the higher.

† W. G. Bell, *The Great Plague in London in* 1665, pp. 275—6.

‡ Leake's plan may be taken as a very careful survey; William Leybourn, a mathematician and trigonometrician, was among those who took part in its production; it was prepared for the Commissioners for the reconstruction.

yard, and that a house had been built in Farringdon Street facing on to the Ditch. This house must have been upon a portion of the site, whence our remains were excavated (see Fig. 4). With regard to the alteration of the Fleet Ditch, it would appear that £27,000 was voted for the canal to Holborn (i.e. "Cutting a navigable river to Holborn-bridge"), and we read: "The attempt to make Fleet-brook or ditch navigable to Holborn-bridge was a mighty chargeable and beautiful work: and though it did not fully answer the designed purpose, it was remarkable for the curious stone bridges over it, and the many huge vaults on each side thereof, to treasure up Newcastle coals for the use of the poor*." If any of these "huge vaults on each side thereof" was made on the Fleet Market frontage of St Bridget's churchyard, we have a further explanation of the origins of our osseous debris.

We will now return to our maps. Overton, 1676, does not mark the churchyard, but he claims to show the "Citty" as now rebuilt. There are houses all down the west side of Fleet Market. This is repeated in Overton's map of 1706 and seems to be indicated in Jeffreys, of 1735. But in A. Lea and R. Glynne (? 1680) the churchyard adjoins the market. None of these maps is of much value. On the other hand Rocque of 1746 shows houses all along, except for a narrow neck or passage to the churchyard (see Fig. 5) between Fleet Market and St Bride's churchyard. Thus the maps seem to indicate that probably a good deal before 1746 the reduction of the churchyard which commenced with the construction of the New Canal had been pushed still farther. The actual area between Fleet Market, Shoe Lane, Stonecutter Street and Harp Alley is very nearly the same in Ogilby and Morgan's map of 1677 and Rocque's map of 1746, but the boundaries of the burial ground have been thrown inwards, not only on the north and east but also on the west (see our Figs. 4 and 5). The modern ordnance map of 1916 reduced to about the size of Rocque's shows a quadrangle, of which the maximum east to west dimension is the same as Rocque's, and likewise the north to south maximum dimension, but the north-east and south-west cuttings off of Rocque's and earlier maps do not appear (cf. Figs. 5 and 6). In other words the yard appears larger in 1916 than in 1746! That the yard approaches more closely Stonecutter Street is probably due to a considerable broadening of the latter street. Such is the history of the Earl of Dorset's gift.

Apart from the excavations for building Gordon House, hundreds of skeletons must still lie under the surface of the 1916 quadrangle. This we understand it is desired to convert into a garage—presumably without excavating the quadrangle—could sanction be obtained. It is at present a waste yard with rubbish heaps.

Now let us return to the documents at St Bride's. Unfortunately the Minute Books of the Vestry from 1665 to 1680 appear at the present time to be missing. This is very regrettable as we should have doubtless been able to trace the events which led to the first halving of the burial ground, and the disappearance under

* *The City Remembrancer*, Vol. II. pp. 31—32. London, 1769.

the pavements of Farringdon Street of the eastern end interments. The following are extracts from the minutes:

June 18th, 1692. "It is left to Messrs ..... to inspect the Lower Churchyard [see note, p. 9] about making of shoppes, warehouses to ye front and to report it to ye next Vestry."

March 13th, 1692—3. "Ordered that ye 2 Churchwardens and ..... be a Committee to take a view of a jetty that is to be made on the Inside of ye Lower Churchyard Wall by Thomas Bye and to report." [The "Inside" is significant.]

October 27th, 1696. "Ordered to inspect into ye books about ye ground and soyl enclosed on ye West side of Fleet Ditch*."

June 28th, 1699. The next entry is very important for it seems to indicate that some building on the churchyard had after all been done for Mr Palmer's benefaction. See our p. 7.

"A Lease granted to Benjamin Tesdale and Thomas Kittrich, Cityzins and Skinners of London of all ye Toft, piece or parcel of grounds...in front from N. to S., 32 foot, from E. to W., 24 foot, the East part of which doth front or ly next unto and against the Street next Fleet River, the North part thereof doth adjoin or ly next to and against a Messuage or Tenement now in the possession of W. Noades, Broker, and the E. [? W.] and S. part doth adjoyn ye Churchyard belonging to the said Parish of St Bridgett als Bride called the lower Church yard† which said Toft.....is scituate lying and being in the said Parish of St Bridgett als Bride, London, and on which now standeth an Almshous belonging to the said Parish of St Bridgett als Bride London with liberty for them the said B. T. and T. K. in case they shall think fitting and convenient in ye building of the said Toft.....to project, erect, make lay or carry the said Building.....in ye ground floor thereof 4 foot over and above ye said twenty four foot into ye said churchyard on the West part of the said Toft....., and also to project etc. the said building by them intended as aforesaid in the 2nd floor thereof seven foot over and above the said 24 ft. into the said churchyard. And the said lease is to commence from Michas next and to hold and continue thenceforth for the term of 99 years, at ye yearly rent of £5 payable quarterly. And in consideration thereof the said B. T. and T. K. are to build one or more messuages or Tenements upon the said premises. It is hereby further ordered that the Alms Hous now standing upon the said premises be granted, bargained and sold to them, the said B. T. and T. K., for the consideration of the said fine by them agreed to be paid and of the charge they are to be at in building as aforesaid, and the said B. T. and T. K. are to hold the same for ever without rendering any account for the same, and to pull down or use the same if they shall think fitting when they shall begin to build upon the same premises."

* This seems to suggest that on the construction of the New Canal a portion of the former churchyard on the Ditch side had been separately enclosed, query with a view to building.

† This passage adequately identifies our burial ground with the "lower churchyard."

Now in interpreting this deed we have to remember that it dates from 1699, thirty-three years after the Great Fire and after the construction of the New Canal, and the cutting off under Fleet Market of half the burial ground. But the Alms House referred to clearly faces Fleet Market and is adjacent to a house in Stonecutter Lane. It seems therefore that this Alms House and the building which was to supplement or replace it were in the north-east corner of the burial ground, just where a house appears in Ogilby and Morgan's map of 1677 (see our Fig. 4). The Alms House must therefore have been built after the Great Fire, and as the recent excavations show right on top of a mass of osseous debris, probably resulting from the reconstructions involved in the New Canal and the Fleet Market on the west side of it. Now the lease just cited should have run out in 1799, but whether that lease was really granted to Benjamin Tesdale and Thomas Kittrich Cityzins and Skinners of London, we cannot say. It does, however, identify the site of the Alms House. Among the documents, however, in the chest in St Bride's Vestry is a lease of land for building purposes, *then occupied by Almshouses*, at the corner of Stonecutter Lane and Fleet Market. The date of that lease is 1788. The Charity Commissioners' Report on St Bride's Foundation shows No. 75 Farringdon Street granted on a lease for 99 years from Lady Day, 1787, i.e. 1788 of the new reckoning. We have therefore four disturbances of the north-east corner of the Dorset burial ground, i.e. (i) the cutting away of half of it for the reconstruction after the Great Fire, (ii) the building of Alms Houses between 1666 and 1677, (iii) the probable building by the firm of Skinners, and (iv) the building again in 1788. Except in so far as these successive buildings may have encroached farther into the burial ground, the mass of broken-up skeletons forming the debris found in the excavation of 1924 must be due to interments taking place before the building of the Almshouses between 1666 and 1677. Thus much for the corner in which the great mass of material was found.

We can, however, throw light on the date at which the remainder of the Fleet Market frontage was built upon. A faculty of the date February 20, 1718, was discovered by the Charity Commissioners and published by them in their Report. In this, after reciting the gift of the 3rd Earl of Dorset (see our p. 3), Lionel Duke of Dorset for himself and his heirs "as much as in him lay" gives leave to the Parishioners of St Bride to erect such houses on the burial ground and grant such leases as they desire. What the parishioners desired to do we are told in the deed itself, namely "to build on part of the premises, containing in length from N. to S. towards Fleet Ditch 69 feet, and from E. to W. 35 feet or thereabouts, the rents and profits of the buildings to be applied towards the support and relief of the poor inhabitants of the said parish." It will be noted that the 24 feet with 7 feet projection of the second story over the graveyard has now increased to 35 feet. Measurements on the modern ordnance map show, omitting the Almshouse site, for the *four* houses between the graveyard and Farringdon Street N. to S. 80 feet* and E. to W. about 43 feet. If we omit the public-

* We may allow for the neck to the burial ground, which would still give the purchaser over measure! Was the measurer the purchasing churchwarden?

house the reach would be 60 feet and not 69, but the purchaser would hardly accept an underestimate. There were, however, other steps necessary to the safe conclusion of the project. The Dean and Chapter of St Peter's, Westminster, were proprietors and owners of the rectory and patrons of the vicarage of the said church of St Bride. They consented to the proposal, but their consent seems to have been linked with the condition that in lieu of the space taken from the already diminished burial ground by the Ditch the Parishioners should set apart a piece of ground belonging to the Parish, adjoining the ancient church, this piece to be converted into, dedicated and employed as a burial place for the use of the parish. We have no evidence whether this condition was carried out; it does not, however, concern our present enquiry. The parishioners next presented a petition to the Bishop for a licence or faculty for these alterations, and he granted the vicar, churchwardens, parishioners and inhabitants of the parish his licence to erect and build upon the said piece of ground such houses as might be convenient or necessary for the support and maintenance of the poor inhabitants of the parish. The recital does not state whether or not the faculty was conditional on the re-interment of the bodies buried in this portion of the graveyard. If it was, the condition appears to have been very imperfectly, if at all, carried out*. The Charity Commissioners' Report shows that the 99 years' building leases of houses on this property must have run out from 1822 to 1829, for new short term leases were granted during that period. This indicates that the building leases were granted before 1723 or skeletons taken up from below these houses must have been before that date, probably much before, as we know the ground was "choked" at the time of the Great Plague. Having got their faculty, how did the parishioners proceed? This is duly described in the Vestry Minutes, to which we once more turn.

August 12, 1720. Ordered that Lord Dorsett's grant of part of the Lower Church Yard to build on be produced and read at the next Vestry.

December 19*th*, 1722. Ordered that that part of the churchyard which is intended to be built upon be cleared from corps at the parish charge, and it is further ordered that the said ground be built upon.

Ordered that the churchwardens give direcions for having the s^{d} ground cleared with expedition. Ordered that the unanimous thanks of this Vestry be given to the Revd. W. Evans the Vicar for his kind offer (wh. this parish will thankfully accept off) of buying a piece of ground to inlarge their lower churchyard †.

* Most of the above facts are taken from the recital of the Faculty, provided in the Charity Commissioners' Report. According to the Report the deeds referred to in the Faculty were not to be found, and that instrument itself was not known till the enquiry. The income from the estate had been paid into the churchwardens' account and had been applied to the usual purposes of a church rate. The parish officers undertook to appropriate the rents to the purposes declared in the Faculty, i.e. solely to the maintenance of the poor inhabitants of the parish.

† If this purchase was made it may account for the difference in shape and size of the yard between 1746 and 1916. See our p. 10.

[The excavations under the former sites of Nos. 75—79 Farringdon Street show how very imperfectly the order that the land "To be built upon be cleared from corps" was carried out!]

February 5th, 1722—23. Ordered that a building Lease or leases be lett of a piece of ground on the west side of Fleet Ditch which belongs to this parish, whereon three houses shall be built the terms to be for 61 yeares, and the ground rent to be reserved on each house 3 pounds per annum.

Ordered that an advertisement thereof be insirted in ten publick Newspapers that persons may have due notice to come and bidd. Ordered that the present Churchwardens...be joynd with the Trustees named in a deed from the L^{d} Dorsett as a Com^{ee} to receive proposalls and treat ab^{t} letting these grounds, the s^{d} Comt^{ee} to report to a Gen^{le} Vestry.

February 22nd, 1722. Ordered that a Lease of a piece of ground by ffleet Ditch part of the Lower Church yard containing in front 69 foot and in depth 35 foot or thereabouts be lett to the best bidder for erecting thereon 3 substantiall brickhouses at the annuall rent of nine pounds.

Ordered that a gateway into the s^{d} Churchyard six foot in front and the heighth of the first story be reserved to the Parish.

Ordered that each bidder for the s^{d} ground advance 5 pounds every bidding.

Ordered that the s^{d} ground be disposed of this day* to the best bidder for a 61 yeares' lease. Then the question being put whether the s^{d} ground be lett entire or in parcelles, Twas ordered that the said ground be let intire.

Ordered That a lease be made of the s^{d} ground from Lady-day next att a "peppercorne" rent for the first yeare & at the rent of nine pounds p. ann. for the remainder of the terme. Then† Mr Churchwarden W^{m} Parsons putt up the s^{d} ground and the wall thereon standing at £300 & severall persons bidding, at last the said W^{m} Parsons bidd £455 for the same, no person advancing higher. It was ordered *Nem. Con.* that M^{r} Parsons have a lease of the s^{d} ground for £455 fine for 61 yrs att nine pounds p. ann. for the last 60 yeare & at pepper corne rent for the first yeare.

Such is the history of the buildings on the Fleet Market side of the Ditch burial ground. We do not know when the Almshouse was built, but the site and building were presumably sold to the firm of Skinners in 1699. The remainder of the site recently excavated was built on in 1722. It is clear therefore that the mass of corpses forming the osseous debris were buried before 1699; the smaller but far from insignificant number taken from the more southern portion of the "Farringdon Street rectangle" (see our p. 2) may to some extent have been buried between 1699 and 1722. But the very perfunctory clearance of corpses, if

* The previous order of *public* announcement could hardly have been carried out, for the terms of the lease and bidding are now settled, and the bidding is to take place on *this day*.

† It would appear that as soon as the terms of the lease had been settled, Senior Churchwarden William Parsons (in the Vestry?) put up the ground for sale, and after a few bids knocked it down to himself!

such took place at all, would most probably have removed those more recently interred and nearer the surface. It is safe therefore to say that the limits of our series are 1610 to 1722, but that the great bulk of the material dates 1610 to 1666, and probably belongs chiefly to interments made when the graveyard became choked at the time of the Great Plague. Material in the eastern side of the burial ground was probably thrown, when the New Canal was carried across the burial ground, helter-skelter into the remainder of the burial ground, possibly into dug-out pits against the north-wall of the Farringdon Street rectangle, and upon this osseous debris the Almshouse must have been built at some date after the Great Fire, and again the whole mass would be disturbed, when Tesdale and Kittrich built their premises on the site of the Almshouse. Their lease should have run out about 1798, but it was probably surrendered in 1788, when a new 99 years' lease was granted for building purposes. It seems therefore impossible that the three ornamented coffin handles found, and said to date from "later than 1760," could be due to interments made under houses built over the burial ground in 1699 and 1722. If they really date later than 1760, then they must be part of refuse from the burial ground thrown into the backyards of the Farringdon Street houses, or into their excavations on rebuilding. The burial ground could hardly encroach again on the sites covered by William Parsons' houses.

The whole story has been developed here, not only because it fixes within fairly narrow limits the period of the crania measured, but because in itself it is extremely instructive. The savage has respect, or at any rate fear, before the bones of his dead. The Egyptian buried his dead on the desert border of his productive delta, where there would be no chance of the growth of population disturbing their bones. The Londoner of late mediaeval times thought nothing of a mass of human corpses as a foundation for his house, and laid down his concrete and mortar so as to form a conglomerate with the bones of his ancestors. To-day where a garden might have been made we desire to lay down the floor of a garage. And thus all surface traces of the Earl of Dorset's burial ground would disappear. But there under the pavement of Farringdon Street its occupants will lie until changes in the roadway or the rebuilding of houses are again undertaken; then the bones may perchance provide material for a scientist who will treat them with greater reverence than the Restoration Vestry or the builder, whose object was to put them as quickly as possible out of sight.

We have to thank very heartily Dr W. G. Howarth, Medical Officer of Health for the City, for his great aid in enabling us to measure this valuable cranial material.

(2) *Measurements and Methods of Measurement.* The direct measurements were similar to those taken by previous workers in the Biometric Laboratory, and detailed accounts of them are given in *Biometrika*, Vol. I. pp. 412—419, and Vol. XIV. pp. 196—200. The definitions of cranial "points" given in the latter paper were followed in the present investigation.

F = Flower's Ophryo-occipital length. L' = Glabellar projective length. L = Glabellar-occipital length. B = Maximum parietal breadth. B' = Least forehead

breadth. H' = Basio-bregmatic height. H = Basion to point vertically above it with skull adjusted on craniophor to Frankfurt horizontal. OH = Craniophor auricular height. LB = Basion to nasion. Q = Craniophor transverse arc through "apex" and terminating at ear rods. Q' = Transverse arc terminating at auricular points. S = Arc from nasion to opisthion. S_1 = Arc nasion to bregma. S_2 = Arc bregma to lambda. S_3 = Arc lambda to opisthion. S_1' = Chord nasion to bregma. S_2' = Chord bregma to lambda. S_3' = Chord lambda to opisthion. U = Horizontal circumference. PH = Alveolar point to tip of anterior nasal spine. $G'H$ = Nasion to alveolar point. GB = Distance between points where zygomatic-maxillary sutures cross lower front ridges of zygomatic arches. J = Zygomatic breadth. NH' = Nasion to base of anterior nasal spine. NH, R and L = Nasion to lowest edge, right and left, of pyriform aperture. NB = Greatest breadth of pyriform aperture. DS = Shortest subtense from bridge of nose to dacryal chord with Mérejkowsky's simometer. DC = Chord dacryon to dacryon. DA = Arc dacryon to dacryon. SS = Shortest subtense from nasal bridge to simotic chord with simometer. SC = Minimum chord between naso-maxillary sutures. O_1 = Breadth of orbit, R and L, using curvature method. O_1' = Breadth of right orbit from dacryon. O_2 = Height of orbit, R and L. EOW = distance between points where the borders of the orbital ridges, right and left, meet the fronto-malar sutures. It is the same as Martin's *innere orbitale Gesichtsbreite*. G_1 = distance from point of spina nasalis posterior to imaginary line tangential to inner rims of alveoli of middle incisors. G_1' = Similar to G_1, but from base of spine. G_2 = From inner alveolar walls at second molars. EH = Palate height; EB = Palate breadth both taken with Pearson's uraniscometer. GL = Basion to alveolar point. *fml* = Basion to opisthion. *fmb* = Greatest breadth of foramen magnum. $P\angle$ = profile angle, found by means of Ranke's goniometer when the skull is in the Frankfurt horizontal position on the craniophor. The angles ($N\angle$, $A\angle$, $B\angle$) of the fundamental triangle were calculated with the aid of Pearson's trigonometer. θ_1, the basio-nasal horizontal angle, is obtained by subtracting $N\angle$ from the supplement of $P\angle$; θ_2, the basio-alveolar horizontal angle, by subtracting $A\angle$ from $P\angle$. The Occipital Index

$$100\,\frac{S_3}{S_3'}\sqrt{\frac{S_3}{24\,(S_3-S_3')}},$$

was obtained from Tildesley's table of this function*.

The capacities were determined by tight packing with mustard seed and weighing in the manner described by Macdonell†.

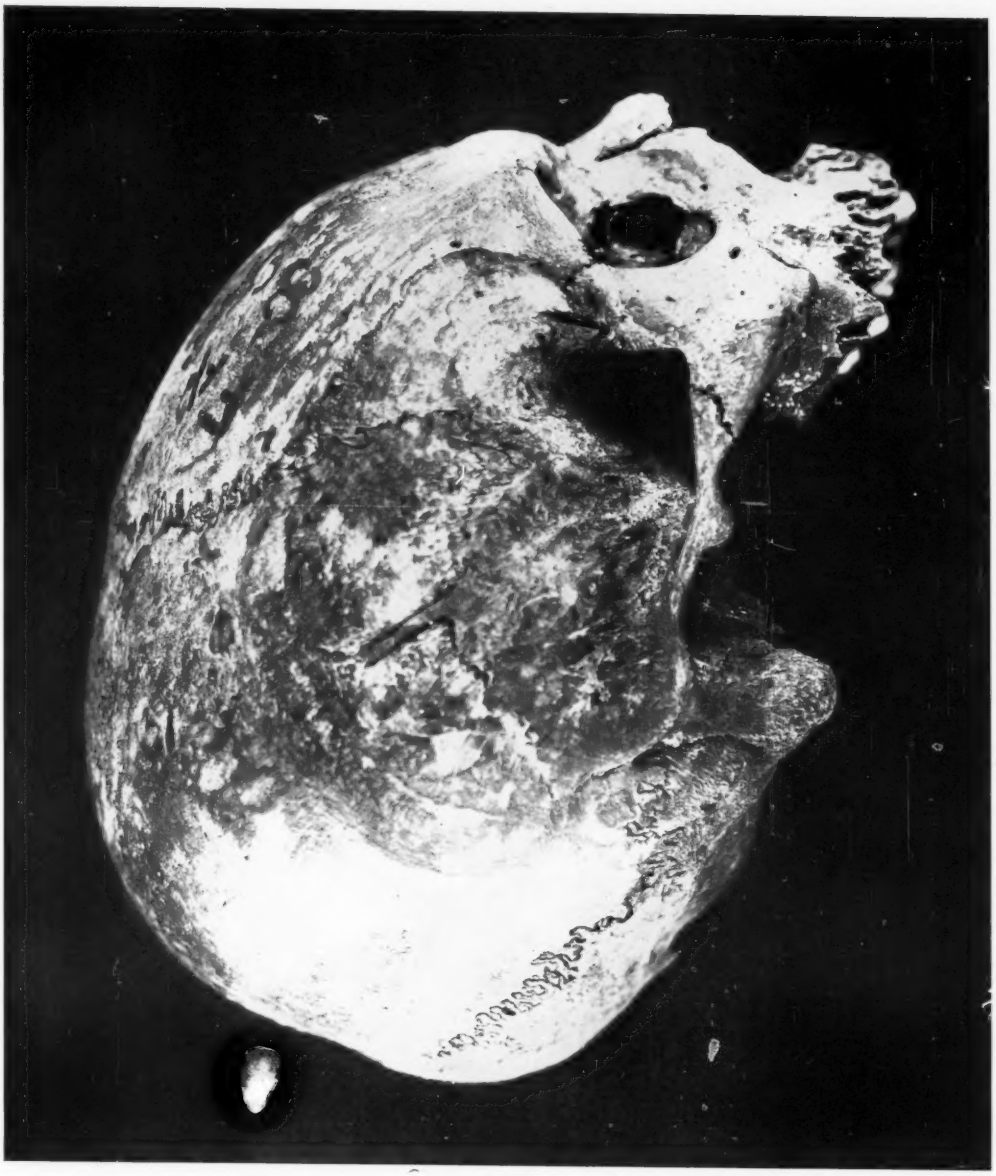
The weight of seed held by the "crâne étalon" γ was determined at the beginning of, and at intervals during, the weeks devoted to this measurement, and the following results were obtained:

(1) 1376·0 gms. (2) 1378·5 gms. (3) 1379·5 gms. (4) 1380·0 gms. (5) 1379·0 gms.

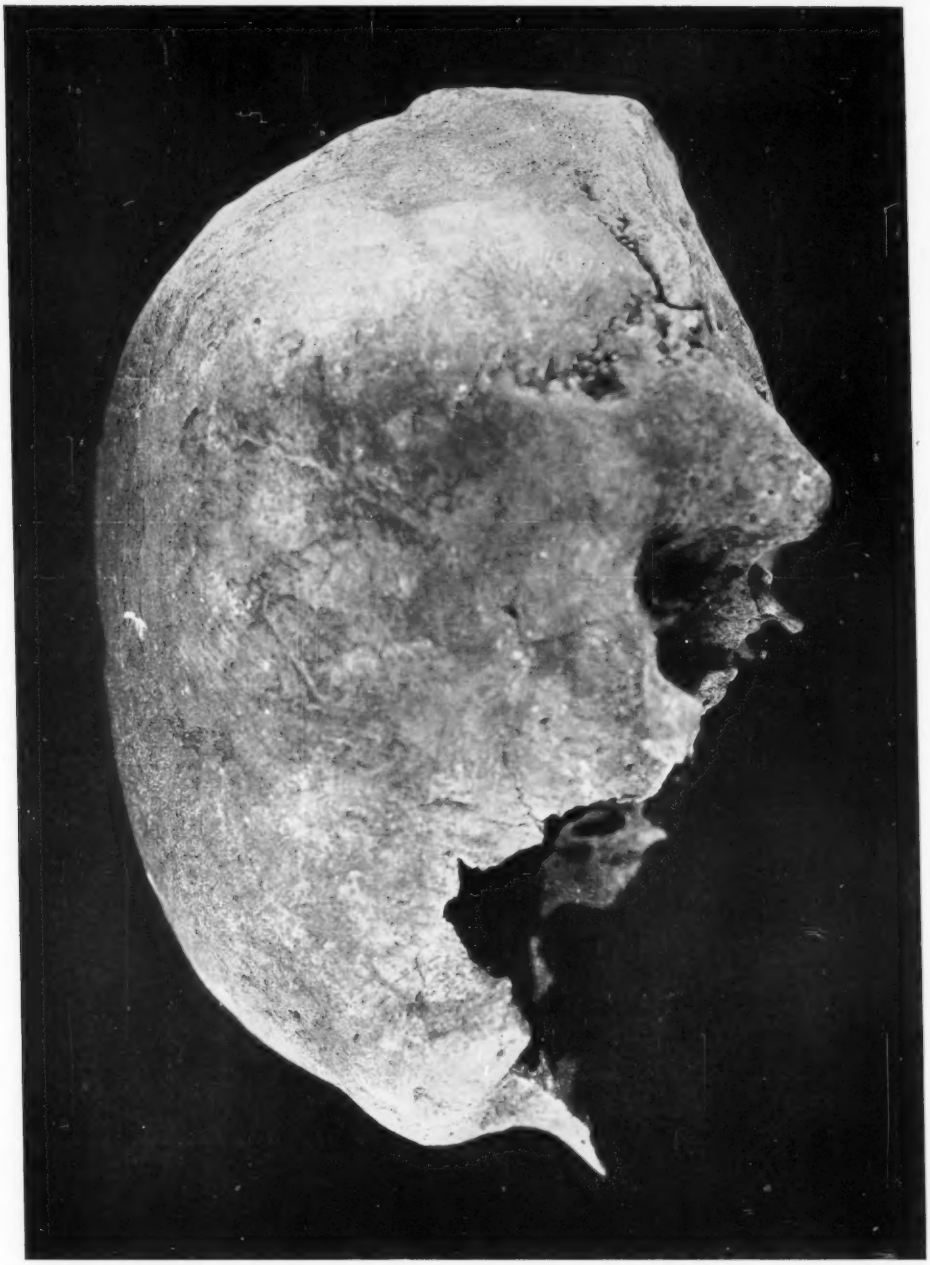
* *Biometrika*, Vol. XIII. p. 261.

† *Biometrika*, Vol. III. pp. 203—206.

Special Skull FA. 44.
Wormian Bone (? Ossicle of Asterion).



Special Skull FA. 89.
Styliform Process on temporal Squama.



Special Skull FA. 136.
Lower occipital Flattening.

Special Skull FA. 114.

Partially healed Injury on R. frontal Bone.

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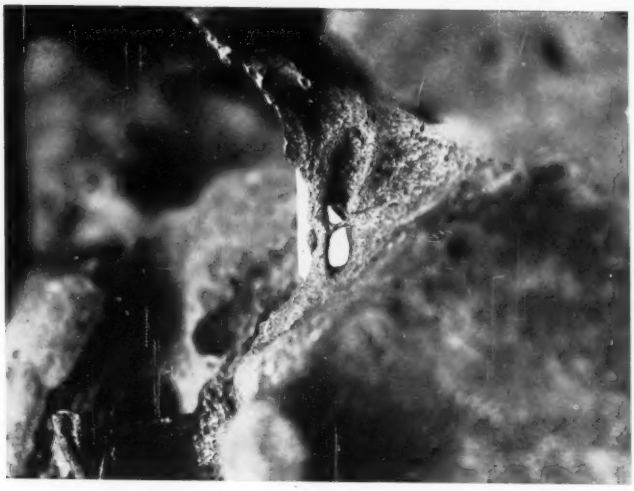
Special Skull FA. 264.
Transverse occipital Groove.



Special Skull FA. 88.

(b) Porus crotaphitico-buccinatorius divided into two externally.

Special Skull FA. 1.

(a) Anomalous process on Pterygoid Plate.

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γ was also filled several times with water, the volume of which was determined by pouring it into a large measuring glass, and was found to be 1755 cm.^{3} Taking 1380 gms. as the weight of seed, the following result is obtained:

$$\text{Vol. of 1000 gms. seed} = \frac{1000}{786{\cdot}3} \text{ cm.}^3 = 1272 \text{ cm.}^3,$$

and this was used to calculate the capacities of the skulls.

Previous determinations on the standard skull γ by Macdonell and Morant gave 765·7 gms. and 772·2 gms. respectively as the weight of 1000 cm.^{3} of seed. The increase in the present instance is partly due to shrinkage of the seed and partly owing to repairs effected on the standard skull which may have altered its capacity to some extent.

The weight of the skulls was not taken as they were too much damaged to give results of any value.

Sex. The skulls were examined first by Mr G. M. Morant with a view to sexing them. Those of doubtful sex were afterwards re-examined by Professor Pearson and Sir George Thane.

Mandibles. Several hundred mandibles were unearthed, but in no case were they attached to the skulls. Many were incomplete, the teeth in the mandibles were not in as good condition as in the upper jaws, and in many instances there was absorption of the alveolus due to loss of teeth and old age. Since the number on which a complete set of measurements could be taken was small, no attempt to determine the sex has been made at present, and in this paper records are given only of those mandibles which were in a good state of preservation. The measurements taken were in accordance with those given in *Biometrika*, Vol. XIV. p. 253.

(3) *"Remarks" on Individual Crania.* The series was examined for anomalies by Sir George Thane and I am much indebted to him for his help in this respect as well as in the question of sexing. A description of these anomalies, together with other remarks concerning the condition of the skulls, will be found accompanying the tables of individual measurements in the Appendices.

The following abbreviations have been used: cal. = calvarium = skull without mandible, f. = face, dome = roof of the skull only, frag. = fragment, br. = broken.

The skulls were examined for the following characters and anomalies, and if no mention be made of any particular feature, it may be assumed that it did not exist in the skull in question.

Age. If no mention of age is made, the skull may be regarded as adult. Obliteration of sutures, considerable loss of teeth and absorption of the alveolus due to old age, have been noted. A record was kept of teeth in process of coming through and basilar synchondrosis was looked for.

Teeth. Many of the teeth were missing, but those left were in good condition and many were well worn. Carious teeth were noted. Also accessory cusps on

the 2nd and 3rd molars. In six cases, one or both of the canines were delayed, and in four of these, the tooth was coming down behind the lateral incisor.

Palate. Each was examined for the presence of a bony ridge over the palatine grooves leading from the pterygo-palatine canal*. It is described as an outer or inner palate bridge according as it is across the outer or inner groove. On account of the damaged condition of the skulls it is very probable that our observations give an entirely inadequate value for the frequency of its occurrence. The occurrence of a torus palatinus was also noted.

Base of Pyriform Aperture. This is represented by the letters P.B. It refers first to the base of the floor of the nasal aperture immediately behind the edge, and is described as "flat," sloping "upwards and outwards" or "downwards and outwards."

Secondly, the edge itself is described as sharp, blunt or rounded. Occasionally the floor and the edge form together an unbroken curve and they are then described as "P.B. rounded." Double edges were also noted. The frequencies found are given in the tables below.

Edge of Pyriform Aperture.

Slope of Floor. Males	Sharp	Blunt	Rounded	Totals
Upwards ...	34	12	9	55
Flat	13	9	5	27
Downwards...	1	3	0	4
Totals	48	24	14	86

There were 3 cases of *PB* rounded and 5 had double edges.

Edge of Pyriform Aperture.

Slope of Floor. Females	Sharp	Blunt	Rounded	Totals
Upwards ...	40	11	6	57
Flat	6	9	5	20
Downwards...	2	1	2	5
Totals	48	21	13	82

There were 2 cases of "P.B. rounded" and 3 had double edges.

In both sexes there was a marked preponderance in favour of P.B. upwards with a sharp edge.

Asymmetry. The Sylvian depressions on each skull were examined and their relative sizes were observed and denoted SR, SL according as the groove was

* See Le Double, *Variations des os de la Face*, p. 266.

greater on the *R* or *L* side. Similar observations were made on the jugular foramen.

	Sylvian Depression		Jugular Foramen	
	♂	♀	♂	♀
Greater on *R* side	42	64	54	66
Equal	36	42	14	21
Greater on *L* side	23	13	22	39

It has been noticed in several other series that the balance is in favour of the right side, and this is borne out by the above observations, but the proportion is distinctly smaller in the present instance.

Asymmetry of other parts of the skull was also noted.

Metopism. The metopic suture was persistent in 14 males, 23 females and 1 child. In 1 of the males, and 5 of the females, part of the suture was completely closed. Contact between the frontal and parietal bones is denoted by LF + RP or RF + LP and the length of the suture between them is given. In 1 male and 5 females the suture was in line with the sagittal suture.

Contact	♂	♀
LF+RP	11	12
RF+LP	1	3

The frequent occurrence of contact between the right parietal and left frontal was very noticeable.

In the Whitechapel crania there were 24 skulls in which the metopic suture was persistent, while in the Moorfields there were 8. The total number of instances in the Farringdon Street skulls is 27, the proportion of metopic skulls is thus much the same in all three series.

Macdonell observed that a persistent frontal suture was accompanied by a slight increase in forehead width although the maximum head breadth was affected to little or no extent*. This conclusion is confirmed by a comparison of these two mean measurements on the metopic skulls of the Farringdon Street series with those for the whole series.

Maximum Head Breadth.

	Farringdon Street		Whitechapel		Moorfields	
	♂	♀	♂	♀	♂	♀
Whole Series...	142·4 (141)	135·7 (180)	141 (135)	135 (140)	143·0 (46)	137·6 (62)
Metopic Skulls	144·7 (14)	134·5 (20)	142 (9)	135 (15)	144·2 (5)	138·6 (3)

* *Biometrika*, Vol. v. p. 102.

Least Forehead Breadth.

	Farringdon Street		Whitechapel		Moorfields	
	♂	♀	♂	♀	♂	♀
Whole Series...	96·8 (152)	93·3 (199)	98 (132)	93 (147)	98·5 (47)	95·2 (64)
Metopic Skulls	100·6 (14)	95·0 (22)	100 (9)	96 (15)	103·7 (5)	101·0 (3)

Interparietals. Unlike the Whitechapel crania, interparietals do not occur frequently in the Farringdon Street series. One skull had a small simple interparietal, one showed traces of separation into *os pentagonale* and *ossa triangularia* and a third had an *os triangulare* on the right side.

Ossicles. All cases of ossicles of considerable size have been noted. In skull *FA.* 44 there was a large Wormian bone 50 × 50 mm. between the parietal bone and the mastoid on the left side. (See Plate I.)

Conformation of the Pterion. Each skull was examined for the presence of ossicles of the pterion; the thrusting forward of a process of the squama temporalis to meet the frontal bone has also been mentioned. Two instances of pterions in *K* were observed.

Post-Coronal Depression. This feature was present in 10 males and in 18 females, but in 6 of the males and 7 of the females it was noted as faint. Post-coronal constriction was noted in 1 male and in 1 female skull. Combining the two we have about 12 per cent. showing this feature as compared with 16 per cent. in the Whitechapel and 29 per cent. in the Moorfields series.

Tympanic Perforation. A record was kept of all cases of perforation of the tympanic plate.

Bathrocephaly. As in the Whitechapel and Moorfields crania, a number of bathrocephalic skulls were observed, 7 males and 7 females exhibiting this feature to a marked extent, and 6 of each sex showing it in a slight degree. This proportion is higher than in the Whitechapel series, where 15 out of 292 were bathrocephalic, but not so great as in the Moorfields crania, where 13 cases were observed out of 120.

Other Features. In addition to the above, the presence of the sutura notha, precondylar growths, and flattening of the obelion have been noted, together with any other singularity of interest.

There were no cases of a horizontal suture across the malar bone.

In 2 skulls the porus crotaphitico-buccinatorius was observed, and in one there was a further bony growth dividing the foramen into two externally, thereby giving separate egress to the two branches of the nervus crotaphitico-buccinatorius. (Plate VI *b.*)

All cases of the pterygo-spinous bridge and foramen were recorded; also transverse perforation of the sphenoidal spine. In a number of skulls signs of beginnings

of these bony ridges were observed, but a record was kept only when the process was very nearly complete.

In 7 skulls there was a projection on the anterior outer surface of the pterygoid plate, probably offering support to the internal maxillary artery. (Plate VI *a*.)

Five skulls were diseased (syphilitic) and one had suffered a severe injury during life of the frontal bone, from which a partial recovery had been made. (Plate IV.)

In skulls *FA*. 264 and 329, the occipital bone was crossed by a deep transverse groove, giving rise to a marked cerebellar overlap. (Plate V.)

Two skulls, *FA*. 136 and *FA*. 165, showed pronounced occipital flattening. (Plate III.) On the right temporal squama of skull *FA*. 89, there was a styliform process, 18 mm. long. (Plate II.)

Except for the lack of interparietals, which were a very noticeable feature of the Whitechapel crania, the Farringdon Street skulls are as remarkable for their anomalies as the other London series.

(4) *Comparative Material.* A detailed study of two series of London crania has already been made, and the chief interest in the present investigation lies in a consideration of the relationship of the Farringdon Street crania to the above-mentioned series, namely the Whitechapel and Moorfields crania, measured by Dr Macdonell, detailed accounts of which will be found in *Biometrika*, Vol. III. p. 191, and Vol. v. p. 86.

These series have been regarded as representative of the typical Londoner of the 17th century, and the aim of the present enquiry is to determine how far Macdonell's conclusions are confirmed and elaborated by the study of a third series of London skulls, in all probability of the same date, although perhaps representative of a lower class of the population.

Macdonell drew attention to the similarity between the London crania and the Long Barrow skulls. He also noted the prevalence of features of a primitive or debased type and confessed "to a certain feeling of unrest, so long as the two largest series of English skulls, of which we have complete measurements, namely the Whitechapel and Moorfields series, give the English these not very flattering cranial characters*."

The Moorfields series is small, consisting of only 120 skulls, but the Whitechapel with 292 and the Farringdon Street with 389 are sufficiently large series to allow deductions to be made with a reasonable degree of reliability.

Although the majority of measurements on the three series are taken in the same way, there are a few for which the methods differ and the characters are not truly comparable. Attention is drawn to these differences in due course. It

* *Biometrika*, Vol. v. p. 99. [More recent investigations of individual crania such as those of Jeremy Bentham, Sir Thomas Browne, and Robert the Bruce (as also in the case of Charles Darwin), suggest that a retreating forehead, if compensated in the parietal region, is by no means incompatible with great intellectual force and strength of character. ED.]

should, however, be noted here that the basio-bregmatic height denoted by Macdonell as H is the same as our H', and in this paper it is tabled as such, while H refers to the height from the basion to the point vertically above it, taken while the skull is on the craniophor and orientated to the Frankfurt plane. This measurement was not taken by Macdonell. A few additional measurements have been taken on the Whitechapel crania. Attention is drawn to these in Table V.

Other English skulls to which we may turn for comparative purposes are the Hythe and Rothwell crania measured by Professor Parsons*.

The Hythe crania are, in all probability, those of Kentish men, dating back to the 14th and 15th centuries, some 200 years earlier than the London series. Measurements were made on 590 crania selected from at least double that number.

The Rothwell crania are believed to be contemporaneous with the Hythe series, and measurements were taken on 127 individuals selected from a population of five or six thousand. 100 of these were classed as male and the remaining 27 as female.

Direct measurements on the Rothwell and Hythe series were made to the nearest mm., whereas in the London series they are given to ·1 mm. in many cases and to ·5 mm. in the remainder.

The characters measured by Parsons are far fewer in number than those taken in this Laboratory, and his indices are calculated from the mean direct measurements and not from the individual indices. Hence a detailed comparison between these and the London series is not possible, but the differences are sufficiently striking to suggest some broad general conclusions.

In his paper on the Whitechapel crania†, Macdonell refers to Sir William Turner's paper on Scottish skulls published in the *Transactions of the Royal Society of Edinburgh* (Vol. XL. Part III. pp. 547—613). The skulls were obtained from various parts of Scotland and were of different dates, and consequently the series could not be considered homogeneous. Mr G. M. Morant has suggested that the skulls should be classified first into eleven groups, and he has calculated the Coefficients of Racial Likeness between them. The eleven groups are termed: (i) Mid Lothian Rural District, (ii) Mid Lothian Sea Coast Village, (iii) Renfrew, (iv) Practical Rooms, (v) Lowlands, (vi) Highlands and Hebrides, (vii) Fifeshire, (viii) East Lothian, (ix) North East Counties, (x) Edinburgh, and (xi) Shetlands.

The coefficients of racial likeness between the first six groups are so small that it was considered they were representative of one type and they were accordingly pooled and termed Lowland Scottish. Similarly the next three have equally low coefficients with one another, and were grouped as Eastern Scottish. The coefficients between the Edinburgh and Shetlands groups or any of the others were high and

* *Journal of the Royal Anthropological Institute*, Vol. XXXVIII. p. 419, and Vol. XL. p. 483.
† *Biometrika*, Vol. III. p. 192.

they must be supposed to represent types different from all the others. Also, since they are based on small numbers, I have ignored them for the present purpose.

I have to thank Mr G. M. Morant for permission to use the above data and for the coefficients of racial likeness (C.R.L.) given in Table III.

(5) *Coefficient of Racial Likeness.* The coefficient of racial likeness

$$\frac{1}{m} S \left\{ \frac{(M_s - M_s')^2}{\frac{\sigma_s^2}{n_s} + \frac{\sigma_s'^2}{n_s'}} \right\} - 1$$

provides a measure of the degree of relationship between two races, based on the consideration of a number of characters between which the correlation is known to be small or non-existent. It was suggested by Professor Pearson and first used by Tildesley*, and a further discussion of its use will be found in *Biometrika*, Vol. XIV. p. 205, and Vol. XVI. p. 11, wherein are also found the standard deviations which are used to replace those of the series under consideration, since the number of crania is, as a rule, too small to enable a determination of the variability of their characters to be made with any degree of accuracy.

In order that coefficients may be comparable it is necessary that the same list of characters should be employed in each determination, and as far as possible I have adhered to the characters used by Morant, a list not identical with that used by Tildesley.

In evaluating the coefficients between the Farringdon Street crania and the series measured by Macdonell it has been necessary to replace H by H', and B/H' has been calculated from the mean values of B and H' for the Whitechapel and Moorfields series. NH', except for the males of the Whitechapel group, O_1 and Q are not strictly comparable owing to the different methods employed in taking the measurements. NH, according to Macdonell, was the nasal height measured to the lowest edge of the pyriform aperture, and this was sometimes on the right side and sometimes on the left. On the Farringdon Street skulls measurements were taken from the nasion to the lowest edge on the right side and on the left, and also to the base of the anterior nasal spine. This would mean that his mean measurement would tend to be longer than any of ours.

For the orbital breadth, O_1, Macdonell used the geodesic method, whereas I have used the curvature method, but the dacryal breadths, O_1', were taken in the same way.

Lastly, both Q and Q' in our case were taken through the "apex," but Macdonell took his measurement through the bregma.

Tables I and II give the coefficients of racial likeness between the three London series.

In deducing the relationship between these series from the coefficients of racial likeness, we must bear in mind that the mean measurements of skulls in

* *Biometrika*, Vol. XIII. p. 247.

the Farringdon Street and Whitechapel series for the characters used in computing the coefficients are approximately the same, while in the Moorfields the number is much less.

TABLE I.

Coefficients of Racial Likeness.

Males	All Characters	Indices and Angles
Farringdon Street (91·9)* and Whitechapel (90·3)	4·15 ± ·18 (27)†	4·85 ± ·29 (10)
Farringdon Street (94·0) and Moorfields (27·5) ...	1·86 ± ·18 (26)	1·41 ± ·29 (10)
Whitechapel (87·2) and Moorfields (24·2) ...	2·05‡ ± ·18 (26)	1·73 ± ·30 (9)

TABLE II.

Coefficients of Racial Likeness.

Females	All Characters	Indices and Angles
Farringdon Street (110·7) and Whitechapel (88·5)	3·92 ± ·20 (22)	5·77 ± ·32 (8)
Farringdon Street (113·2) and Moorfields (39·6)...	2·89 ± ·18 (26)	0·96 ± ·29 (10)
Whitechapel (86·0) and Moorfields (34·8) ...	5·20 ± ·18 (27)	5·36 ± ·29 (10)

We may then compare directly the coefficients between the Moorfields and the other two series, and, whether we judge by all characters or by angles and indices alone, the males of the Moorfields series appear to be as closely related to the Farringdon Street as to the Whitechapel crania. Between the two latter the coefficient is higher. This does not necessarily suggest that the Farringdon Street crania are further removed from the Whitechapel than they are from the Moorfields, since in the latter series the material is hardly sufficient to enable us to make a reliable determination of the degree of difference between it and any other series.

For the females, the coefficients are on the whole higher, markedly so between the Whitechapel and Moorfields.

Judging by the indices, the closest resemblance in shape is found between the Farringdon Street and Moorfields crania, and the widest divergence between the Farringdon Street and Whitechapel. An examination of the individual characters and indices demonstrates, as will be shown later, that the chief points of difference between these latter series lie in their height and parietal breadth, and it is these factors and the index B/H' ($\alpha = 33{\cdot}07$) which are chiefly responsible for the higher coefficient between these series.

The C.R.L.'s, then, suggest that in our new series we are dealing with a type very closely allied to the 17th century crania previously known to us, but, at the

* Mean number of skulls for characters used in computing C.R.L.

† Number of characters on which the coefficient is based.

‡ *Biometrika*, Vol. XIV. p. 209.

same time, it appears that there are significant differences between them. The characters in which these differences are most apparent will be discussed in a later section of this paper.

The coefficients of racial likeness between the Farringdon Street and the Hythe and Rothwell series have been calculated but the numbers of characters available for this purpose in the latter two series are very few. A comparison with these crania is reserved to the next section of this paper.

We will now turn to the Scottish skulls and endeavour to ascertain the degree of their relationship to the Londoners.

In Tables III and IV are given the coefficients of racial likeness between them.

TABLE III.*

Coefficients of Racial Likeness. Males.

	Lowland Scottish (48·2)		Eastern Scottish (21·1)	
	All Characters	Indices and Angles	All Characters	Indices and Angles
Farringdon Street (100·3)	5·61 ± ·19 (23)	9·38 ± ·33 (7)	9·78 ± ·19 (23)	15·82 ± ·33 (7)
Whitechapel (98·4) ...	3·37 ± ·19 (23)	7·06 ± ·33 (7)	13·94 ± ·19 (23)	26·46 ± ·33 (7)
Moorfields (30·4) ...	3·87 ± ·21 (19)	6·32 ± ·38 (5)	7·31 ± ·21 (19)	13·85 ± ·38 (5)

TABLE IV.

Coefficients of Racial Likeness. Females.

	Lowland Scottish (24·0)		Eastern Scottish (6·0)	
	All Characters	Indices and Angles	All Characters	Indices and Angles
Farringdon Street (120·2)	8·34 ± ·19 (23)	12·52 ± ·33 (7)	0·61 ± ·19 (23)	1·10 ± ·33 (7)
Whitechapel (99·0) ...	4·65 ± ·21 (20)	7·78 ± ·36 (6)	−0·07 ± ·21 (20)	0·37 ± ·36 (6)
Moorfields (41·1) ...	6·41 ± ·20 (21)	11·23 ± ·36 (6)	1·05 ± ·20 (21)	1·32 ± ·36 (6)

The coefficients of racial likeness for all characters suggest that the Lowland Scottish males are moderately like the Londoners, the least resemblance being with the Farringdon Street crania. The Eastern Scottish appear to be quite distinct from the English and indeed from the Lowland Scottish also, the coefficients between the Scottish types for males being 7·89 ± ·19 for 23 characters and 15·14 ± ·33 for 7 indices and angles.

The females of the Lowland Scottish type exhibit less affinity for the English. In the case of the Moorfields crania the coefficient is considerably higher than is

* The coefficients between the Scottish, Whitechapel and Moorfields series were calculated by Mr G. M. Morant.

the case for the males, as was observed in the comparison of the Moorfields with the Whitechapel series.

With regard to the Eastern Scottish female type we are unable on the basis of our present data to assert a real difference between it and the English.

A noticeable feature in both tables is the high value of the coefficient determined from angles and indices alone, in most cases it being nearly twice as great as that determined from all characters, a difference much more marked than occurred in the coefficients between the English series themselves. It appears, then, that the Scottish skulls are chiefly differentiated from the English by the shape of their heads, but it should be noted that this is equally true of the two types of Scottish crania themselves.

(6) *Comparison of Mean Direct Measurements.* The C.R.L.'s have indicated a close resemblance between the various London series, suggesting, at the same time, that there are certain significant differences, and these will appear in a detailed examination of the mean characters themselves.

Table V gives the mean direct measurements of the three series with their probable errors.

The values of α, where $$\alpha = \frac{(M_s - M_s')^2}{\frac{\sigma_s^2}{n_s} + \frac{\sigma_s'^2}{n_s'}},$$ *

between various characters have been determined and are given in Table VI. The function has been calculated on the usual supposition that the variabilities of the characters are the same for different races and equal to those of the long series of Egyptian skulls, Series E. The values of

$$\alpha' = \frac{(M_s - M_s')^2}{\frac{\sigma_s^2}{n_s} + \frac{\sigma_s'^2}{n_s'}},$$

using the standard deviations of the characters of the English series themselves, have also been determined, and are given in the columns denoted by α'.

As usual, if the value of α exceeds 2·7 the characters are regarded as exhibiting differences, which are possibly significant provided α is less than 6·1, but above that value the probability of their representing samples from the same population is exceedingly small.

The Farringdon Street and Whitechapel series are both of considerable length, and since the mean values of most of the characters are based on approximately the same number of skulls in each series, it should be possible to make a reliable comparison.

Turning first to the males, we see there are 9 characters for which α is greater than 6·1, and these will indicate the chief points of difference between the two series. The most striking values are those of the indices H'/L and B/H', which

* *Biometrika*, Vol. XIV. p. 212.

are evidently due to the superior height of the Whitechapel crania, together with their narrower breadth across the parietal bones. It is this discrepancy in height which is the most noticeable feature of difference between the two series. The larger circumference of the Farringdon Street skulls is due to their excess in breadth, although actually in forehead width the Whitechapel are significantly greater.

The length from basion to nasion is markedly different in the two series, the Whitechapel being the longer.

The foraminal length is distinctly greater in the Farringdon Street crania, but the foraminal breadths and indices do not differ significantly.

As was mentioned in the previous section, the orbital breadth was taken from different points in the two series. This, however, does not affect the measurement of the height, which is greater in the Farringdon Street. The dacryal breadth is greater in the Whitechapel skulls by 0·7 mm., which is actually the difference between the O_1 measurements, so we may safely conclude that their orbits are significantly wider than the orbits in our series.

The Farringdon Street crania, then, are distinguished from the Whitechapel in that they are lower, wider, although with narrower foreheads, and have somewhat rounder orbits.

Of the characters exhibiting differences of doubtful significance, the values of α lying between 2·7 and 6·1, the most distinctive feature is afforded by G_1, the longer palate occurring in the Farringdon Street series. The palate widths of the Farringdon Street and Moorfields crania agree closely. Macdonell gave 36·8 as the mean value of the palate width of the Whitechapel series, based on 66 skulls.

The measurement has been retaken independently by Mr G. M. Morant, and I have to acknowledge my thanks to him for permission to use this and other measurements that he has taken on the same series. Reference to these has been made in Table V. He found only 32 skulls on which he considered the measurement, G_2, could be made with a reasonable degree of accuracy, and their mean value was 39·6, a result in very close agreement with the mean palate width of the Farringdon Street and Moorfields crania. This is a measurement for which the personal equation is large, and caution must be exercised in comparing results obtained by different workers.

The ophryo-occipital length is greater in the Whitechapel skulls, the difference is less marked in the glabellar-occipital length, and the glabellar-projective length taken when the skull is on the craniophor is actually greater in the Farringdon Street.

The nasal angle is a little smaller in the Farringdon Street crania, but the difference is barely significant.

The remaining characters exhibit no difference in type. They include most of the facial indices and measurements, $G'H/GB$, NB/NH, $P\angle$, $A\angle$, $G'H$, J, NH, R, NB and also B/L', fmb/fml, Q, S, fml, and C.

TABLE V. *Comparative Table of Means.*

Character	Males			Females		
	Farringdon Street	Whitechapel	Moorfields	Farringdon Street	Whitechapel	Moorfields
C	1481·5 ± 9·46 (86)	1476·9 ± 9·73 (72)	1473·8 ± 19·01 (22)	1296·5 ± 6·12 (132)	1299·9 ± 8·51 (80)	1365·3 ± 13·68 (31)
F	186·1 ± ·36 (140)	187·4 ± ·35 (138)	186·9 ± ·59 (45)	180·0 ± ·31 (188)	180·1 ± ·36 (143)	182·5 ± ·52 (65)
L′	188·6 ± ·50 (73)	187·8 ± ·45 (72)	188·0 ± 1·02 (19)	179·2 ± ·59 (68)	180·1 ± ·57 (57)	182·5 ± ·86 (23)
L	188·8 ± ·37 (139)	189·1 ± ·36 (137)	189·2 ± ·57 (44)	181·6 ± ·34 (182)	180·4 ± ·35 (140)	183·4 ± ·51 (63)
B	142·4 ± ·34 (141)	140·7 ± ·31 (135)	143·0 ± ·53 (46)	135·7 ± ·25 (180)	134·7 ± ·27 (140)	137·6 ± ·45 (62)
B′	96·8 ± ·25 (152)	98·0 ± ·25 (132)	98·5 ± ·41 (47)	93·3 ± ·19 (199)	93·1 ± ·23 (147)	95·2 ± ·34 (64)
H	130·4 ± ·42 (73)	—	—	122·8 ± ·40 (66)	—	—
H′	129·7 ± ·31 (118)	132·0 ± ·34 (122)	129·8 ± ·75 (34)	122·5 ± ·29 (163)	124·6 ± ·30 (124)	123·6 ± ·46 (47)
OH	110·0 ± ·40 (76)	112·1 ± ·25 (135)	111·3 ± ·47 (46)	105·2 ± ·44 (69)	106·7 ± ·25 (143)	106·9 ± ·38 (59)
LB	100·1 ± ·28 (118)	101·6 ± ·25 (119)	98·5 ± ·52 (35)	95·8 ± ·24 (154)	95·3 ± ·24 (122)	95·9 ± ·43 (46)
Q	306·3 ± 1·00 (75)	307·9 ± ·72 (115)	305·4 ± 1·49 (32)	290·4 ± 1·00 (67)	294·0 ± ·71 (122)	293·1 ± 1·16 (42)
Q′	309·0 ± 1·04 (75)	—	—	293·1 ± ·92 (67)	—	—
S	378·8 ± ·85 (128)	377·1 ± ·81 (131)	378·5 ± 1·28 (40)	362·3 ± ·68 (167)	362·8 ± ·84 (130)	365·6 ± 1·26 (53)
S_1	129·3 ± ·35 (153)	—	129·3 ± ·56 (44)	124·1 ± ·33 (185)	—	125·8 ± ·57 (53)
S_2	128·1 ± ·44 (147)	—	128·7 ± ·78 (43)	123·8 ± ·37 (201)	—	123·6 ± ·68 (52)
S_3	120·6 ± ·46 (135)	—	120·5 ± ·90 (40)	114·8 ± ·36 (182)	—	117·0 ± ·59 (49)
S_1'	113·3 ± ·26 (153)	—	—	108·4 ± ·25 (187)	—	—
S_2'	114·5 ± ·34 (148)	—	—	110·3 ± ·29 (201)	—	—
S_3'	97·3 ± ·30 (132)	—	98·1 ± ·63 (40)	94·0 ± ·24 (184)	—	95·9 ± ·59 (49)
U	530·0 ± ·96 (126)	524·3 ± ·88 (126)	527·1 ± 1·60 (37)	507·8 ± ·82 (166)	503·8 ± ·85 (136)	512·7 ± 1·53 (56)
PH	19·2 ± ·21 (80)	—	—	18·2 ± ·22 (71)	—	—
G′H	70·5 ± ·33 (82)	70·2 ± ·30 (75)	68·1 ± ·62 (20)	65·7 ± ·35 (73)	65·9 ± ·40 (62)	64·2 ± ·47 (27)
GB	91·4 ± ·48 (74)	90·9 ± ·45 (55)	93·9 ± ·77 (15)	87·0 ± ·35 (64)	84·9 ± ·41 (58)	86·9 ± ·79 (18)
J	131·0 ± ·50 (43)	130·1 ± ·57 (43)	129·0 ± 1·19 (7)	120·4 ± ·45 (52)	120·3 ± ·58 (33)	122·0 ± ·69 (18)
NH′	51·0 ± ·25 (84)	* 50·3 (76)		47·2 ± ·23 (79)	—	—
NH, R	51·8 ± ·21 (86)	† 51·2 ± ·20 (79)	†50·4 ± ·39 (20)	48·1 ± ·20 (83)	† 48·7 ± ·22 (67)	† 48·0 ± ·36 (27)
NH, L	51·7 ± ·22 (89)	—	—	48·0 ± ·20 (79)	—	—
NB	24·6 ± ·15 (83)	24·3 ± ·17 (70)	24·0 ± ·30 (18)	23·5 ± ·14 (80)	23·2 ± ·14 (64)	23·4 ± ·25 (26)
DS	12·8 ± ·13 (79)	‡ 12·1 ± ·11 (50)	—	11·6 ± ·16 (74)	‡ 10·8 ± ·12 (50)	—
DC	22·2 ± ·16 (84)	‡ 21·5 ± ·21 (50)	—	21·3 ± ·18 (81)	‡ 20·6 ± ·19 (50)	—
DA	36·1 ± ·27 (78)	‡ 34·8 ± ·26 (50)	—	33·0 ± ·30 (75)	‡ 31·5 ± ·28 (50)	—
SS	4·6 ± ·82 (82)	‡ 4·7 ± ·10 (50)	—	4·0 ± ·08 (76)	‡ 4·2 ± ·07 (50)	—
SC	9·2 ± ·14 (81)	‡ 9·4 ± ·17 (50)	—	9·0 ± ·13 (80)	‡ 9·1 ± ·17 (50)	—
O_1, *R*	42·3 ± ·12 (81)	43·0 ± ·16 (68)	42·3 ± ·22 (18)	40·3 ± ·13 (75)	41·0 ± ·14 (62)	40·9 ± ·23 (25)
O_1, *L*	42·4 ± ·11 (85)	43·1 ± ·15 (63)	41·8 ± ·23 (20)	40·7 ± ·13 (74)	41·2 ± ·13 (57)	40·9 ± ·24 (22)
O_2, *R*	34·3 ± ·17 (83)	33·4 ± ·18 (69)	32·8 ± ·34 (18)	33·7 ± ·15 (78)	33·7 ± ·13 (64)	32·6 ± ·27 (25)
O_2, *L*	34·3 ± ·16 (89)	33·5 ± ·15 (67)	32·8 ± ·32 (20)	33·6 ± ·15 (72)	33·6 ± ·12 (64)	32·8 ± ·34 (22)
O_1'	39·8 ± ·13 (81)	*40·5 (67)	—	38·5 ± ·13 (80)	—	—
EOW	98·1 ± ·30 (77)	—	—	94·1 ± ·29 (79)	—	—

* Measured by G. M. Morant. † Macdonell's *NH*, to lowest point of pyriform aperture *R* or *L*.

‡ Ryley and Bell, *Biometrika*, Vol. IX. p. 403.

TABLE V. *(continued). Comparative Table of Means.*

TABLE V.—(*continued*). *Comparative Table of Means.*

Character	Males			Females		
	Farringdon Street	Whitechapel	Moorfields	Farringdon Street	Whitechapel	Moorfields
G_1	49·7 ± ·23 (67)	48·3 ± ·22 (69)	48·1 ± ·69 (17)	46·8 ± ·26 (65)	45·1 ± ·26 (57)	45·9 ± ·43 (20)
G_1'	46·0 ± ·22 (69)	—	—	43·8 ± ·22 (69)	—	—
G_2	39·3 ± ·28 (53)	§36·8 ± ·24 (66)	39·7 ± ·41 (15)	37·5 ± ·28 (48)	35·2 ± ·24 (58)	37·0 ± ·40 (22)
GL	94·4 ± ·45 (64)	—	—	90·8 ± ·45 (61)	90·4 ± ·40 (58)	92·1 ± ·76 (25)
EH	11·1 ± ·24 (53)	—	—	10·3 ± ·29 (48)	—	—
EB	39·3 ± ·28 (53)	—	—	37·5 ± ·28 (48)	—	—
fml	36·8 ± ·19 (115)	*35·9 (117)	35·4 ± ·32 (36)	34·8 ± ·14 (157)	—	34·3 ± ·24 (50)
fmb	30·6 ± ·14 (106)	*30·3 (112)	29·7 ± ·21 (34)	29·1 ± ·12 (152)	—	29·0 ± ·23 (50)
100 B/L'	75·5 ± ·27 (73)	75·2 ± ·24 (69)	75·1 ± ·52 (18)	75·0 ± ·23 (66)	74·6 ± ·27 (55)	75·4 ± ·30 (21)
100 H/L'	69·1 ± ·25 (72)	—	—	68·8 ± ·29 (65)	—	—
100 B/L	75·4 ± ·20 (132)	74·3 ± ·19 (131)	75·5 ± ·31 (42)	74·8 ± ·15 (167)	74·7 ± ·18 (130)	75·1 ± ·21 (57)
100 H/L	69·3 ± ·26 (71)	—	—	68·9 ± ·29 (65)	—	—
100 B/H	109·1 ± ·37 (73)	—	—	109·1 ± ·32 (64)	—	—
100 H'/L	68·6 ± ·20 (115)	70·0 ± ·20 (120)	68·4 ± ·42 (31)	67·9 ± ·19 (155)	69·1 ± ·18 (117)	67·2 ± ·28 (44)
100 B/H'	109·8 ± ·33 (117)	‖{106·6} (122)	{110·2} (34)	110·6 ± ·30 (158)	{108·1} (124)	{111·3} (44)
100 $(B-H')/L$	6·7 ± ·23 (113)	{4·3} (120)	{7·1} (42)	7·0 ± ·20 (149)	{5·6} (117)	{7·9} (44)
100 $G'H/GB$	77·1 ± ·52 (66)	76·5 ± ·50 (53)	72·8 ± ·86 (14)	75·8 ± ·53 (56)	77·9 ± ·57 (54)	73·6 ± ·64 (18)
100 $NB/NH, R$	47·5 ± ·32 (81)	¶47·6 ± ·37 (70)	47·6 ± ·66 (18)	49·0 ± ·33 (77)	47·8 ± ·33 (64)	48·7 ± ·52 (26)
100 $NB/NH, L$	47·5 ± ·33 (81)	—	—	49·4 ± ·35 (76)	—	—
100 $O_2/O_1, R$	81·0 ± ·46 (79)	77·7 ± ·38 (68)	77·4 ± ·69 (17)	83·8 ± ·34 (75)	82·5 ± ·37 (62)	79·8 ± ·75 (25)
100 $O_2/O_1, L$	80·9 ± ·38 (85)	77·9 ± ·32 (63)	78·5 ± ·64 (20)	82·8 ± ·45 (72)	81·7 ± ·38 (57)	80·3 ± ·84 (22)
100 O_2/O_1'	85·9 ± ·49 (79)	{82·5} (67)	—	87·8 ± ·39 (76)	—	—
100 fmb/fml	83·4 ± ·39 (106)	*84·5 (112)	84·2 ± ·77 (34)	84·1 ± ·31 (149)	—	84·5 ± ·60 (47)
100 DS/DC	58·1 ± ·71 (78)	‡56·8 ± ·71 (50)	—	54·5 ± ·64 (74)	‡52·9 ± ·63 (50)	—
100 SS/SC	50·7 ± ·96 (81)	‡50·8 ± 1·20 (50)	—	44·6 ± ·79 (76)	‡46·6 ± ·8 (50)	—
100 G_2/G_1	78·8 ± ·55 (46)	§76·3 ± ·55 (61)	82·7 ± 1·05 (13)	79·8 ± ·65 (42)	77·7 ± ·62 (51)	81·2 ± ·71 (19)
100 EH/EB	28·5 ± ·64 (51)	—	—	27·6 ± ·71 (48)	—	—
$P\angle$	85°·9 ± ·26 (65)	86°·1 ± ·33 (63)	84°·5 ± ·69 (15)	85°·6 ± ·24 (57)	87°·1 ± ·27 (52)	84°·8 ± ·35 (19)
$N\angle$	64°·2 ± ·31 (64)	65°·2 ± ·29 (69)	66°·6 ± ·58 (17)	64°·6 ± ·35 (60)	64°·7 ± ·23 (57)	66°·7 ± ·37 (26)
$A\angle$	73°·3 ± ·31 (64)	73°·4 ± ·28 (69)	72°·4 ± ·61 (17)	74°·1 ± ·34 (60)	73°·9 ± ·29 (57)	73°·3 ± ·30 (26)
$B\angle$	42°·5 ± ·31 (64)	41°·4 ± ·20 (69)	41°·1 ± ·44 (17)	41°·3 ± ·29 (60)	41°·4 ± ·27 (57)	40°·0 ± ·35 (26)
θ_1	29°·8 ± ·29 (60)	28°·7 ± ·22 (59)	29°·4 ± ·53 (14)	29°·8 ± ·32 (53)	28°·1 ± ·24 (50)	28°·5 ± ·33 (19)
θ_2	12°·5 ± ·28 (60)	12°·9 ± ·29 (59)	11°·6 ± ·43 (14)	11°·7 ± ·29 (53)	13°·1 ± ·34 (50)	11°·5 ± ·37 (19)
Oc. I.	58·0 ± ·16 (131)	—	58·5 ± ·23 (40)	59·1 ± ·12 (181)	—	59·2 ± ·28 (49)

* Measured by G. M. Morant.

‡ Ryley and Bell, *Biometrika*, Vol. IX. p. 403.

§ This measurement was retaken recently by Mr G. M. Morant. He found only 32 skulls which he considered sufficiently well preserved to give accurate measurements. Their mean is 39·6 and the corresponding value of G_2/G_1 is {82·0}.

‖ Indices in curled brackets are calculated from the mean direct measurements.

¶ Nasal Index from G. M. Morant's NH' {NB/NH'} = 48·3 (70).

TABLE VI.

Values of $\alpha = \frac{n_s n_s'}{n_s + n_s'} \left(\frac{M_s - M_s'}{\sigma_s} \right)^2$ *between the London Crania.*

Character	Farringdon Street and Whitechapel				Farringdon Street and Moorfields			
	Males		Females		Males		Females	
	α	α'	α	α'	α	α'	α	α'
B/L'	0·45	0·31	0·73	0·57	0·32	0·21	0·39	0·51
H'/L	13·31	11·03	11·74	9·91	0·11	0·08	2·05	1·94
B/H'	33·07	22·02	26·21	14·20	0·23	0·14	1·07	0·55
Oc. I.	—	—	—	—	0·70	1·46	0·04	0·02
G'H/GB	0·43	0·32	5·75	3·30	8·68	8·35	3·44	3·37
NB/NH, R	1·92	1·28	3·54	3·05	0·01	0·01	0·12	0·11
fmb/fml	1·97	1·89	—	—	0·49	0·40	0·14	0·12
G_2/G_1	4·19	6·27	2·34	2·58	3·34	4·95	0·68	1·09
P ∠	0·12	0·10	7·03	7·87	2·28	1·61	2·13	1·61
N ∠	3·03	2·56	0·25	0·23	7·06	5·10	8·64	8·73
A ∠	0·03	0·03	0·10	0·09	0·91	0·80	1·00	1·41
F	3·57	2·98	0·04	0·02	0·66	0·60	13·27	7·68
B	8·80	6·37	3·85	3·28	0·55	0·42	8·14	6·09
B'	6·20	5·30	0·24	0·20	6·33	5·79	12·19	10·75
OH	12·63	9·05	7·86	3·99	2·85	2·04	6·90	3·86
LB	8·46	7·19	1·37	1·01	4·38	3·34	0·03	0·02
S	1·20	0·96	0·17	0·10	0·02	0·02	3·97	2·43
U	11·20	8·86	8·68	5·21	1·27	1·10	7·27	3·61
G'H	0·20	0·20	0·09	0·06	5·38	5·36	3·14	2·95
J	0·93	0·71	0·01	0·01	1·15	1·10	1·78	1·72
NH, R	1·74	2·68	1·98	1·79	3·75	4·50	0·03	0·03
NB	1·09	0·78	1·19	1·04	1·70	1·44	0·07	0·05
O_2, *R*	9·30	5·85	0·00	0·00	9·18	7·10	6·77	5·63
G_1	6·00	8·74	10·02	9·77	3·13	2·17	1·41	1·49
G_2	0·26	0·19	20·60	17·54	0·27	0·29	0·59	0·47
fml	7·70	5·22	—	—	8·81	6·42	1·98	1·52
fmb	1·06	1·01	—	—	4·51	5·66	0·09	0·07
C	0·06	0·05	0·07	0·05	0·07	0·05	14·00	9·59

α' = value of $\frac{n_s n_s' (M_s - M_s')^2}{n_s \sigma_s'^2 + n_s' \sigma_s^2}$, where σ_s and σ_s' are found from the series themselves, here adequate in number.

Consideration of the females of the two series leads us to much the same conclusions. We find the differences in height and breadth somewhat less marked, but the highest values of α are still found for the indices H'/L, B/H'. In forehead width the two groups are in close agreement.

The horizontal circumference is again significantly greater in the Farringdon Street, but the sagittal arcs are almost identical. The difference between the transverse arcs is more marked than was the case in the males.

The orbital measurements are in close agreement, there being no significant difference in the heights; the Whitechapel appear to be wider.

The angles of the fundamental triangle are identical in the two series, but the profile angle in the Farringdon Street crania is smaller.

The ophryo-occipital lengths are the same, and the similarity in length is confirmed by L and L'. No differences are found in B/L', LB, $G'H$, J, NB, and C.

The difference in nasal heights is small, and since Macdonell's result should be reduced to be comparable with ours, it is extremely likely that the two are very similar.

Between the Moorfields and Farringdon Street crania the greatest differences are shown by the characters $G'H/GB$, $N\angle$, B', O_2, R, and fml. The high value of $G'H/GB$ is due to the excess in facial height on the part of the Farringdon Street crania, coupled with their defect in facial width. In forehead width the Moorfields are significantly greater, but there is no difference in the breadth across the parietal bones.

The two series are in close agreement as regards breadth, in height the Moorfields have a slight advantage, but it is barely significant, and the indices B/L', H'/L, B/H' are very nearly the same.

The orbits of the Farringdon Street crania are again significantly higher, and probably there is very little difference in their widths.

The palatine widths are in good accordance; the length is greater in the Farringdon Street.

The nasal height is significantly greater in the Farringdon Street series, the difference in breadth being insignificant.

The remaining characters in which the two series resemble one another closely are $Oc.I$, fmb/fml, $P\angle$, $A\angle$, S, U, J, and C.

The agreement between the females is not so close and it should be noted that the numbers in each series are larger.

The superiority in length of the Moorfields is borne out by F, L, and L'; they are significantly wider, and consequently they have a considerably greater capacity. The indices B/L', H'/L, B/H' agree very well, and the facial measurements are more alike than was the case for the males. It thus appears that the distinctive difference between them is that of size.

A study, then, of the direct measurements of the three series indicates a very close relationship between them. The Farringdon Street are lowest, in breadth they occupy an intermediate position, the Moorfields being the widest, and if we omit the Moorfields females the length is the same for all three. Their cephalic indices place them on the border line between dolichocephalic and mesaticephalic skulls.

In facial measurements they are very similar, the Farringdon Street group being rather nearer to the Whitechapel than to the Moorfields. The orbital measurements give greater height to the Farringdon Street crania.

In foraminal breadth the three series are in accord, the greatest length being found in the Farringdon Street.

The agreement in the value of $A\angle$ is steady throughout, it is fairly close in $P\angle$, but $N\angle$ is definitely smallest in the Farringdon Street crania.

In capacity (Table VII) the three series resemble one another very closely, except in the case of the Moorfields females, which are considerably larger than the females of either of the other groups and agree more closely with the capacities determined on modern English heads by the Pearson and Lee formulae. The males, 17th century and modern, have very similar capacities.

TABLE VII. *Capacities.*

	Males	Females
Farringdon Street ...	1481·5 (86)	1296·5 (132)
Whitechapel	1476·9 (72)	1299·9 (80)
Moorfields	1473·8 (22)	1365·3 (31)
*British Association ...	1495	1323·5
*Bedford College Students	—	1390 (30)

The capacities deduced for the living are of course not for the general population, but for highly selected classes.

Of the characters not included in Table VI the only ones we need consider are the simotic and dacryal arcs, chords and subtenses. These measurements have been made on the Farringdon Street and Whitechapel crania only, and the agreement is close. The simotic chords are sensibly identical both in males and females, the dacryal chords are very nearly the same, while the difference in the dacryal arcs is slight but significant.

These facts, taken in conjunction with the other nasal measurements, suffice to show that the nasal organs of the two series resemble one another extremely closely.

θ_1, θ_2 are calculated from $P\angle$, $N\angle$, and $A\angle$, and the differences in the values of θ_1 and θ_2 are clearly accounted for by discrepancies in the measured angles.

The conjoint indices of the Farringdon Street and Moorfields series only differ significantly for the females. The index of the Whitechapel group is lower in both sexes.

We will now turn to the α' columns given in Table VI which give us an appreciation of the differences between the various characters, based on the standard deviations of the characters of each series. The variabilities were found to be, in most cases, slightly greater than those of the Egyptian Series E, thereby decreasing the measure of the divergence between the characters to some slight extent. The reduction is only appreciable in 3 cases, viz. *OH* for the Whitechapel females and *F* and *U* for the Moorfields females, and in 9 cases the change is in the other direction, but it is not significant and 6 of them occur in the comparison

* *Phil. Trans.* Vol. 196, pp. 252 and 257. Equations used:

$$C = \cdot 000337\,(l-11)\,(b-11)\,(h-11) + 406\cdot 01\ \delta,$$
$$C = \cdot 000400\,(l-11)\,(b-11)\,(h-11) + 206\cdot 60\ \varphi.$$

with the Moorfields series, where the small number of skulls renders the determination of the standard deviations very unreliable. The effect will be to reduce the coefficient of racial likeness, thus between the Farringdon Street and Whitechapel it will be $3{\cdot}14 \pm {\cdot}18$ for 27 characters and between the Moorfields and Farringdon Street, $1{\cdot}77 \pm {\cdot}18$ for 26 characters.

(7) *Prediction Formulae for Cranial Capacity.* Before we turn to the other series with which we have to compare the London crania, we shall make a slight digression to consider the determination of the capacity of the skull from the length, breadth and height. The Lee and Pearson intraracial regression formulae were obtained for German, Aino and Naqada races, male and female, and the mean formulae derived from these have been used for races whose relationship to any one of the above is not sufficiently close to justify the choice of one particular equation.

Intraracial formulae were obtained by the method of least squares for ten races, European and otherwise, and Dr Isserlis has since found the intraracial regression formulae for negroes*, who were excluded in the above determinations.

Now that three English series of the same period and locality are available, it was thought worth while to determine the regression formulae from these data, and accordingly the products $L \times B \times H'$ and $L \times B \times OH$ were determined for the individual skulls whenever possible, and these products were correlated with the capacities found by mustard seed. The products are measured in cubic centimetres.

The numbers of skulls for which these products could be calculated were as follows:

Product	Sex	Farringdon Street	Whitechapel	Moorfields	Totals
$L \times B \times H'$	♂	85	66	22	173
$L \times B \times H'$	♀	124	78	29	231
$L \times B \times OH$	♂	63	66	22	151
$L \times B \times OH$	♀	62	79	29	170

The results obtained are given below:

Sex	Number	Mean Capacity	Mean LBH' in cm.^{3}	σ_C	$\sigma_{LBH'}$	$r_{C,\,LBH'}$
♂	173	1481	3500	125·53	288·19	·841
♀	231	1307	3029	110·32	256·75	·851

The regression lines are

		Probable error of mean
♂	$C = {\cdot}000366\,LBH' + 198{\cdot}87$	$\frac{45{\cdot}8}{\sqrt{n}}$
♀	$C = {\cdot}000366\,LBH' + 199{\cdot}43$	$\frac{38{\cdot}9}{\sqrt{n}}$

.....(1).

* *Biometrika*, Vol. x. p. 188.

Sex	Number	Mean Capacity	Mean $LB(OH)$ in cm.^{3}	σ_C	$\sigma_{LB(OH)}$	$r_{C,\,LB(OH)}$
♂	151	1480	2965	122·34	248·47	·844
♀	170	1302	2588	122·34	250·41	·863

The regression lines are

		Probable error of mean
♂	$C = ·000416\,LB(OH) + 247·86$	$\frac{44·3}{\sqrt{n}}$
♀	$C = ·000422\,LB(OH) + 210·83$	$\frac{41·8}{\sqrt{n}}$

.....(2).

To test the errors involved in the determination of capacities from these formulae, 20 male and 20 female skulls were selected at random, the formulae were applied to them and the calculated capacities were compared with those obtained by the mustard seed method. For males, the mean error of the 20 skulls as found from (1) is 47·0, from (2) 56·8, and for females, 37·3 from (1) and 38·7 from (2), corresponding to probable errors of (1) 39·7, (2) 48·0 for males and (1) 31·5, (2) 32·7 for females.

The formulae were then applied to the mean L, B, H' and OH of the three London series and the capacities thus determined are given below :

		Seed	Formula (1)	Formula (2)
Farringdon Street	♂	1481·5	1475·1	1478·2
,, ,,	♀	1296·5	1304·3	1304·9
Whitechapel	♂	1476·9	1484·3	1488·6
,,	♀	1299·9	1307·6	1304·9
Moorfields	♂	1473·8	1484·2	1500·6
,,	♀	1365·3	1341·0	1349·3

The extent of the error introduced by using the product of the means instead of the mean product has been discussed by Dr Lee*, who found an error of less than 1 per cent.

The equation to determine the error is

$$\text{Mean product} = \text{product of means}\,(1 + v_B v_{H'} r_{BH'} + v_L v_{H'} r_{LH'} + v_B v_L v_{BL}).$$

These correlations and the coefficients of variation have been found for the Whitechapel crania, and applying them to the above formula we have

♂ Mean product = 3512·0 (1 + ·001,021) = 3512·0 + 3·6,

♀ Mean product = 3027·8 (1 + ·001,485) = 3027·8 + 4·5,

showing that the errors involved are quite insignificant.

* *Phil. Trans.* Vol. 196, p. 250.

Finally we must compare our equations with the Lee and Pearson formulae to ascertain the increase in accuracy they enable us to obtain. We will consider their formulae (9)—(13) which are

Mean of three intraracial formulae for Aino, Naqada and German crania
$$\left.\begin{array}{ll} ♂ & C = \cdot 000337\, LB(OH) + 406\cdot 01 \\ ♀ & C = \cdot 000400\, LB(OH) + 206\cdot 60 \end{array}\right\} \ldots\ldots (9),$$

Interracial formulae deduced from means of ten races
$$\left.\begin{array}{ll} ♂ & C = \cdot 000365\, LB(OH) + 359\cdot 34 \ldots\ldots (10), \\ ♀ & C = \cdot 000375\, LB(OH) + 296\cdot 40 \ldots\ldots (11), \end{array}\right.$$

Interracial formulae deduced from means of ten races
$$\left.\begin{array}{ll} ♂ & C = \cdot 000266\, LBH' + 524\cdot 6 \quad \ldots\ldots\ldots (12), \\ ♀ & C = \cdot 000156\, LBH' + 812\cdot 0 \quad \ldots\ldots\ldots (13). \end{array}\right.$$

	Farringdon Street		Whitechapel		Moorfields	
	♂	♀	♂	♀	♂	♀
Lee and Pearson (9)	1402·6	1243·6	1411·1	1243·7	1420·8	1285·7
" " (10) and (11)	1438·8	1268·6	1448·0	1268·7	1458·5	1308·0
" " (12) and (13)	1452·1	1282·9	1458·8	1284·3	1458·7	1298·6
English (1)	1475·1	1304·3	1484·3	1307·6	1484·2	1341·0
" (2)	1478·2	1304·9	1488·6	1304·9	1500·6	1349·3
Seed	1481·5	1296·5	1476·9	1299·9	1473·8	1365·3

A glance at the above table will show that the Lee and Pearson formulae give values for the mean capacities of the English crania, which are in all cases too low and less accurate than our new equations.

The best values they give are obtained from equations (12) and (13), i.e. the equations involving the basio-bregmatic height, whereas in applying the formulae to the races from which they were deduced the reverse is the case, better results being obtained by using the auricular height formulae. In the case of the formulae deduced from our English data, the basio-bregmatic height gives an error no greater than that involved by using the auricular height. The conclusion we can draw from these results is that already emphasised by Lee and Pearson, namely, that we must proceed with extreme caution when we apply a regression formula worked out for a special race to obtain the mean capacity of a second race, not closely allied to it *.

(8) *Comparison of London Crania with those of Hythe and Rothwell.* Reverting to the study of individual measurements and having assured ourselves of the close similarity between the Farringdon Street and the other London crania, we will now investigate their relationship to the Hythe and Rothwell skulls.

* Using the English three-arcs formula given by Lewenz and Pearson (*Biometrika*, Vol. III. p. 370) we find for males that the Farringdon Street crania have a mean capacity of 1490·3, the Whitechapel 1477·5 and the Moorfields 1480·0. These values are as close to those determined by the seed method as are those deduced from our formulae (1) and (2), and the same accord is found by using the formulae for female crania.

Table VIII gives the mean measurements of the Hythe and Farringdon Street series. The Hythe measurements are given to the nearest mm. and the indices are calculated from the mean characters.

TABLE VIII.

Mean Measurements of Hythe and Farringdon Street Crania.

Character	Males		Females	
	Hythe	Farringdon Street	Hythe	Farringdon Street
F	177 (324)	186·1 (140)	171 (230)	180·0 (188)
L	179 (319)	188·8 (139)	171 (227)	181·6 (182)
B	143 (324)	142·4 (141)	140 (230)	135·7 (180)
B'	99 (318)	96·8 (152)	96 (228)	93·3 (199)
H'	133 (307)	129·7 (118)	128 (222)	122·5 (163)
OH	120 (294)	110·0 (76)	116 (215)	105·2 (69)
B/L	{79·9}	75·5 (73)	{81·9}	74·8 (167)
H'/L	{74·3}	68·6 (115)	{74·9}	67·9 (155)
C	1441	1481·5 (86)	1206	1296·5 (132)

The most noticeable feature of this table is the extreme shortness of the Hythe crania, which distinguishes them at once from all the London series. The difference in breadth across the parietal bones is only significant in the females; in this character they are nearest to the Moorfields. Their cephalic index is high, bringing them almost into the brachycephalic class, whereas the London crania border on the dolichocephalic.

The forehead width is also greater than occurs in any of the London series.

In basio-bregmatic height the Hythe crania are markedly superior to the low vaulted Londoners; in auricular height the difference amounts to 1 cm., but this is chiefly due to the fact that on the former the measurement was taken from the centre of the ear-passage and not from the auricular points.

Parsons states that he determined the capacities of the Hythe crania by the Pearson and Lee formulae,

Length × Breadth × Auricular height × ·000337 + 406 for ♂ skulls,

and Length × Breadth × Auricular height × ·000400 + 206 for ♀ skulls.

Applying these to the mean measurements of the Hythe crania he gave 1441 c.c. for the mean capacity of the males and 1206 c.c. for the females. Using the male formula for the males of the Farringdon Street series, we find their mean capacity is 1402·6 c.c., but since the auricular heights were measured from different points, these results are not strictly comparable. If instead we use our formula (1),

$$C = \cdot 000366\, L \times B \times H' + 198 \cdot 87,$$

we find the Hythe male crania have a mean capacity of 1444·9 c.c. and the Farringdon Street of 1475·1 c.c. By mustard seed, the capacity of the latter was found to be 1481·5 c.c.

Apparently Parsons did not use the auricular height formula for the female crania (or if he did made some slip), since this gives 1316·8 c.c., not 1206·0 c.c., as the mean capacity.

Using our formula $C = \cdot 000366\, L \times B \times H' + 199{\cdot}43$ for females, we obtain 1321·0 c.c. for the Hythe crania and 1304·3 c.c. for the Farringdon Street. The capacity of the latter as determined by mustard seed was 1296·5 c.c. It would appear, then, that the capacities of the two series do not differ to any great extent.

The Hythe crania are clearly differentiated from the Farringdon Street, the difference in shape being very striking, and we are bound to conclude that the Kentish man of the 14th century represents a type quite distinct from the 17th century Londoner*.

In Table IX are given the mean measurements of the Rothwell and Farringdon Street series, and in Table X are the values of α for some of the characters.

In basio-bregmatic height the Rothwell skull is superior to the Farringdon Street, agreeing, in this character, very closely with the Whitechapel crania. It is significantly shorter than the London crania but is considerably nearer to them than to the Kentish man.

TABLE IX.

Comparative Table of Means.

	F	L	B	B'	H'	$100\,B/L$	$100\,B/F$	$100\,H'/L$	$100\,B/H'$
Farringdon Street ♂	186·1 (140)	188·8 (139)	142·4 (141)	96·8 (152)	129·7 (118)	75·5 (73)	{76·5} (140)	68·6 (115)	109·8 (117)
Rothwell ♂	184·1 (100)	185·9 (99)	141·7 (100)	100·8 (96)	132·5 (93)	{76·2} (99)	{77·0} (100)	{71·3} (93)	{106·9} (93)
Farringdon Street ♀	180·0 (188)	181·6 (182)	135·7 (180)	93·3 (199)	122·5 (163)	74·8 (167)	{75·4} (180)	67·9 (155)	110·6 (158)
Rothwell ♀	181·6 (27)	181·9 (27)	138·3 (27)	96·9 (27)	128·4 (26)	{76·0} (27)	{76·2} (27)	{70·6} (26)	{107·7} (26)

TABLE X.

Values of $\dfrac{n_s n_s'}{n_s + n_s'} \left(\dfrac{M_s - M_s'}{\sigma_s}\right)^2$ *between the Rothwell and London Crania. Males.*

	$100\,B/L$	$100\,H'/L$	$100\,B/H'$	F	B	B'	H'
Farringdon Street ...	2·89	43·37	23·57	7·11	1·26	57·39	24·02
Whitechapel ...	28·31	10·24	0·26	19·23	2·53	26·56	0·80
Moorfields	2·18	22·62	14·66	7·41	2·35	10·18	10·69

* The C.R.L. between the Hythe and Farringdon Street crania is $82{\cdot}50 \pm {\cdot}32$ for eight characters, and between the Rothwell and Farringdon Street crania is $21{\cdot}80 \pm {\cdot}33$ for seven characters—all that are available!

In parietal breadth it is intermediate between the Farringdon Street and Whitechapel crania.

The cephalic index is higher than that found in any of the London series, placing the Rothwell crania in the mesaticephalic class.

The greatest differences between the females of the Rothwell and Farringdon Street series occur, as in the males, in the characters H', B', H'/L, B/H'.

(9) *Further Comparison of London and Lowland Scottish Crania.* The coefficients of racial likeness between the London and Scottish male crania suggested a relationship between the Lowland Scottish type and the three London series which does not diverge very widely from that which exists between the several London series themselves (see p. 25). It will be worth while, then, considering in further detail the resemblances between the English and the Lowland Scottish types. The Eastern Scottish type, on the other hand, appears for males to be well removed from them all, and as the data are not abundant, a closer study would not repay us.

Table XI gives the mean measurements of the Lowland Scottish type together with the α's between them and the Farringdon Street crania.

TABLE XI. *Mean Measurements of Lowland Scottish Group and Values of α between Lowland Scottish and Farringdon Street Series.*

Character	Lowland Scottish ♂	Lowland Scottish ♀	α ♂	α ♀
$100\,B/L$	75·3 (54)	77·0 (28)	0·05	17·57
$100\,H'/L$	70·9 (52)	70·9 (27)	21·91	25·30
$100\,B/H'$	{106·4}(52)	{108·6}(27)	21·26	5·57
$100\,NB/NH'$	44·5 (44)	44·0 (23)	26·98	36·55
$100\,O_2/O_1'$	87·3 (48)	89·2 (24)	2·29	0·22
$N\angle$	{64°·4}(38)	{65°·9}(14)	0·09	1·81
$A\angle$	{73°·5}(38)	{71°·3}(14)	0·08	7·65
L	188·8 (54)	179·6 (28)	0·00	4·27
B	142·1 (54)	138·2 (28)	0·16	7·41
B'	97·0 (53)	92·6 (28)	0·96	0·84
H'	133·6 (52)	127·3 (27)	32·34	40·06
LB	102·0 (52)	95·2 (23)	8·27	0·58
$*Q$	306·7 (54)	295·0 (26)	0·05	5·21
S	379·3 (51)	363·2 (27)	0·06	0·17
U	528·9 (50)	509·1 (27)	0·23	0·28
GH'	71·5 (39)	68·3 (19)	1·53	7·21
J	131·5 (43)	122·6 (20)	0·26	3·64
NH'	52·2 (46)	50·6 (24)	5·02	31·48
NB	23·1 (44)	22·2 (23)	20·65	11·22
O_1'	39·3 (48)	37·8 (24)	2·70	3·72
O_2	34·3 (48)	33·6 (24)	0·00	0·05
fml	35·7 (51)	34·9 (26)	7·01	0·05
C	1493·1 (44)	1338·2 (22)	0·30	3·87

* Turner's transverse arc is taken like Macdonell's from one "supra-auricular point" to the other "supra-auricular point," through the bregma. On 75 Farringdon Street crania, I found the ratio of the apical to the bregmatic transverse arc to be ·9942, so that this difference of method of measurement is of very small importance.

The most striking values are H'/L, B/H', NB/NH' and H'. The Lowland Scottish are considerably higher than the Londoners, in length they are identical with the Farringdon Street, and in breadth the difference is not significant. The cephalic indices are in very good accord.

The breadth of the pyriform aperture is considerably less in the Scottish skulls, while the nasal height is greater, resulting in a sensible difference in the nasal indices.

The Farringdon Street crania are shorter in length from nasion to basion, and the foraminal length is greater; but in no other character do we find a significant difference. The arcs, orbits, angles and capacities bear very strong resemblances.

The characters in which differences do occur are few, but the discordance in these is strongly marked.

In the females the agreement is not so close. Again the greater height of the Scottish skulls is brought forcibly to our notice, but here we find lack of accord in length and breadth, the Farringdon Street being both longer and narrower. The cephalic index of the Lowland Scottish is 77·0, bringing the females well into the mesaticephalic class, whereas the males are approaching the dolichocephalic.

The differences in the nasal height and breadth are even more pronounced and the Scottish skulls have a significantly greater facial height.

The resemblance between the Lowland Scottish and the Whitechapel crania is yet more marked. The calvarial measurements are almost identical, and it is only in the facial characters that significant differences are shown between the two series.

Values of α greater than 5 are found for

$$100\,NB/NH'\ (\alpha = 26{\cdot}73), \qquad 100\,O_2/O_1'\ (\alpha = 19{\cdot}24),$$
$$NB\ (\alpha = 12{\cdot}43), \qquad NH'\ (\alpha = 12{\cdot}12),$$
$$O_2R\ (\alpha = 6{\cdot}28), \qquad 100\,B/L\ (\alpha = 5{\cdot}53).$$

We are, then, led to the conclusion that the Lowland Scottish group is representative of a type distinct from any of our London series but resembling them much more closely than do either the Hythe or Rothwell crania. The outstanding difference between the Scottish and Farringdon Street skulls is in the basio-bregmatic height, the agreement between the former and the Whitechapel crania being very close in this respect.

The facial differences shown between the Scottish and Whitechapel groups do not exist between the former and the Farringdon Street series except in the breadth of the pyriform aperture.

(10) *On the Variability of the Farringdon Street Crania.* The standard deviations and coefficients of variation of the characters of the Farringdon Street crania are given in Table XII. They will be found to agree well with the variabilities of the Whitechapel and Moorfields series, which are given in *Biometrika*, Vol. v. p. 92.

In capacity, length and breadth, the differences between the coefficients of variation, both for males and females, are not significant. In height (H'), the males

TABLE XII. *Variabilities of Characters of Farringdon Street Crania.*

Character	Males			Females		
	No.	Standard Deviation	Coefficient of Variation	No.	Standard Deviation	Coefficient of Variation
C	86	130·12 ± 6·69	8·78 ± ·45	132	104·28 ± 4·33	8·04 ± ·34
F	140	6·39 ± ·26	3·43 ± ·12	188	6·35 ± ·22	3·53 ± ·12
L'	73	6·29 ± ·35	3·34 ± ·19	68	7·21 ± ·42	4·02 ± ·23
L	139	6·46 ± ·26	3·42 ± ·12	182	6·70 ± ·24	3·69 ± ·13
E	141	5·90 ± ·24	4·14 ± ·17	180	5·07 ± ·18	3·74 ± ·13
B'	152	4·58 ± ·18	4·73 ± ·18	199	3·97 ± ·13	4·26 ± ·14
H	73	5·33 ± ·30	4·09 ± ·23	66	4·83 ± ·28	3·93 ± ·23
H'	118	5·06 ± ·22	3·90 ± ·17	163	5·40 ± ·20	4·41 ± ·17
OH	76	5·17 ± ·28	4·70 ± ·26	69	5·40 ± ·31	5·13 ± ·30
LB	118	4·47 ± ·20	4·47 ± ·20	154	4·33 ± ·17	4·52 ± ·17
Q	75	12·89 ± ·71	4·27 ± ·23	67	12·16 ± ·71	4·19 ± ·24
Q'	75	13·35 ± ·74	4·32 ± ·24	67	11·11 ± ·65	3·79 ± ·22
S	128	14·20 ± ·60	3·75 ± ·16	167	12·96 ± ·48	3·58 ± ·13
S_1	153	6·47 ± ·25	5·00 ± ·19	185	6·74 ± ·24	5·43 ± ·19
S_2	147	7·99 ± ·31	6·24 ± ·25	201	7·81 ± ·26	6·31 ± ·21
S_3	135	7·84 ± ·32	6·50 ± ·27	182	7·13 ± ·25	6·21 ± ·22
S_1'	153	4·77 ± ·18	4·21 ± ·16	187	5·13 ± ·18	4·73 ± ·17
S_2'	147	6·20 ± ·24	5·41 ± ·21	201	6·15 ± ·21	5·58 ± ·19
S_3'	131	5·12 ± ·21	5·26 ± ·22	184	4·82 ± ·17	5·13 ± ·18
U	126	15·92 ± ·68	3·00 ± ·13	166	15·70 ± ·58	3·09 ± ·11
PH	80	2·79 ± ·15	14·53 ± ·79	71	2·78 ± ·16	15·27 ± ·88
G'H	82	4·45 ± ·23	6·31 ± ·33	73	4·41 ± ·25	6·71 ± ·38
GB	74	6·16 ± ·34	6·74 ± ·38	64	4·21 ± ·25	4·84 ± ·29
J	43	4·84 ± ·35	3·69 ± ·27	52	4·83 ± ·32	4·01 ± ·27
NH'	84	3·44 ± ·23	6·75 ± ·45	79	3·02 ± ·16	6·40 ± ·35
NH, R	86	2·89 ± ·15	5·58 ± ·29	83	2·76 ± ·14	5·74 ± ·28
NH, L	89	3·12 ± ·16	6·03 ± ·31	79	2·60 ± ·14	5·42 ± ·29
NB	83	2·01 ± ·11	8·17 ± ·43	80	1·88 ± ·10	8·00 ± ·43
DS	79	1·77 ± ·09	13·83 ± ·76	74	2·01 ± ·11	17·33 ± ·99
DC	84	2·16 ± ·11	9·73 ± ·51	81	2·38 ± ·13	11·17 ± ·60
DA	78	3·56 ± ·19	9·86 ± ·54	75	3·86 ± ·21	11·70 ± ·65
SS	82	1·10 ± ·06	23·91 ± 1·33	76	0·99 ± ·05	24·75 ± 1·43
SC	81	1·92 ± ·10	20·87 ± 1·15	80	1·75 ± ·06	19·44 ± 1·08
O_1, *R*	81	1·56 ± ·08	3·69 ± ·20	75	1·64 ± ·09	4·07 ± ·22
O_1, *L*	85	1·48 ± ·08	3·49 ± ·18	74	1·63 ± ·09	4·00 ± ·22
O_2, *R*	83	2·36 ± ·12	6·88 ± ·36	78	1·98 ± ·11	5·88 ± ·32
O_2, *L*	89	2·30 ± ·12	6·70 ± ·34	72	1·93 ± ·11	5·74 ± ·32
O_1'	81	1·67 ± ·09	4·20 ± ·22	80	1·75 ± ·09	4·55 ± ·24
EOW	77	3·88 ± ·21	3·96 ± ·22	79	3·87 ± ·21	4·11 ± ·22
G_1	67	2·78 ± ·16	5·59 ± ·33	65	3·05 ± ·18	6·52 ± ·39
G_1'	69	2·65 ± ·15	5·76 ± ·33	69	2·71 ± ·16	6·19 ± ·36
G_2	53	3·05 ± ·20	7·76 ± ·51	48	2·92 ± ·20	7·79 ± ·54
GL	64	5·34 ± ·32	5·66 ± ·34	61	5·22 ± ·32	5·75 ± ·35
EH	53	2·63 ± ·17	23·69 ± 1·64	48	2·95 ± ·20	28·64 ± 2·13
EB	53	3·04 ± ·20	7·74 ± ·51	48	2·85 ± ·20	7·60 ± ·53
fml	115	3·00 ± ·13	8·15 ± ·36	157	2·51 ± ·10	7·21 ± ·28
fmb	106	2·20 ± ·10	7·19 ± ·33	152	2·16 ± ·08	7·42 ± ·29
100 *B/L'*	73	3·47 ± ·19	4·60 ± ·26	66	2·79 ± ·16	3·72 ± ·22
100 *H/L'*	72	3·09 ± ·17	4·47 ± ·25	65	3·52 ± ·21	5·12 ± ·30
100 *B/L*	132	3·48 ± ·14	4·62 ± ·19	167	2·96 ± ·11	3·96 ± ·15
100 *H/L*	71	3·22 ± ·18	4·65 ± ·26	65	3·48 ± ·21	5·05 ± ·30
100 *B/H*	73	4·75 ± ·27	4·35 ± ·24	64	3·84 ± ·23	3·52 ± ·21
100 *H'/L*	115	3·24 ± ·14	4·72 ± ·21	155	3·45 ± ·13	5·08 ± ·20
100 *B/H'*	117	5·27 ± ·23	4·80 ± ·21	158	5·53 ± ·21	5·00 ± ·19
100 *(B − H')/L*	113	3·59 ± ·16	53·58 ± 3·02	149	3·60 ± ·14	51·43 ± 2·49
100 *G'H/GB*	66	6·24 ± ·37	8·09 ± ·48	56	5·85 ± ·37	7·72 ± ·49
100 *NB/NH, R*	81	4·32 ± ·23	9·09 ± ·49	77	4·25 ± ·23	8·67 ± ·47
100 *NB/NH, L*	81	4·38 ± ·23	9·22 ± ·49	76	4·49 ± ·25	9·09 ± ·50
100 O_2/O_1, *R*	79	6·02 ± ·32	7·43 ± ·40	75	4·42 ± ·24	5·27 ± ·29
100 O_2/O_1, *L*	85	5·17 ± ·27	6·39 ± ·33	72	5·61 ± ·32	6·78 ± ·38
100 O_2/O_1'	79	6·40 ± ·34	7·45 ± ·40	76	5·07 ± ·28	5·77 ± ·32
100 *fmb/fml*	106	5·90 ± ·27	7·07 ± ·33	149	5·59 ± ·22	6·65 ± ·26
100 *DS/DC*	78	9·33 ± ·50	16·06 ± ·89	74	8·19 ± ·45	15·03 ± ·85
100 *SS/SC*	81	12·75 ± ·68	25·15 ± 1·41	76	10·19 ± ·56	22·84 ± 1·31
100 G_2/G_1	46	5·55 ± ·39	7·04 ± ·50	48	6·69 ± ·46	8·39 ± ·58
100 *EH/EB*	52	6·88 ± ·46	24·14 ± 1·69	48	7·26 ± ·50	26·02 ± 1·91
P ∠	65	3°·15 ± ·19	3·67 ± ·22	57	2°·72 ± ·17	3·18 ± ·20
N ∠	64	3°·68 ± ·22	5·73 ± ·34	60	4°·05 ± ·25	6·29 ± ·39
A ∠	64	3°·63 ± ·22	4·95 ± ·30	60	3°·89 ± ·24	5·25 ± ·32
B ∠	64	3°·65 ± ·22	8·59 ± ·52	60	3°·36 ± ·21	8·12 ± ·50
θ_1	60	3°·32 ± ·20	11·14 ± ·69	53	3°·42 ± ·22	11·40 ± ·76
θ_2	60	3°·16 ± ·19	25·28 ± 1·65	53	3°·08 ± ·20	26·32 ± 1·84
Oc. I.	131	2·71 ± ·11	4·67 ± ·20	181	2·45 ± ·09	4·15 ± ·15

of the Moorfields series are significantly more variable, but the Farringdon Street group, male and female, show greater variability for *OH*.

The circumferences and arcs agree very closely.

The variability of *G'H* is very similar in the males and females of the Farringdon Street series, but there is a considerable sexual difference in the Whitechapel. The males are less variable than the Farringdon Street males, but the females are significantly more so.

The divergence in variability for *G'H* in the females is not significant, but in the males the value in the Farringdon Street series is just significantly greater.

The variabilities of the orbital breadths cannot be compared, but the Farringdon Street orbits are more variable in height.

The foraminal lengths of the Farringdon Street and Moorfields series are equally variable, there is a significant difference in the breadths and a marked sexual difference in the Moorfields, but it must be remembered that the Moorfields series is short.

The variabilities of the indices are in very fair agreement.

In the absolute measurements the male has a greater coefficient of variation in 18, the female in 29 characters. In the indices and angles the male has a greater standard deviation in 14, the female in 12 characters. The male is therefore not more variable than the female.

Finally, we may conclude that the variabilities of the different characters are sufficiently close in the Farringdon Street and Whitechapel series to confirm the belief that we are dealing with homogeneous material.

(11) *Comparison of Type Contours.* Transverse, horizontal and sagittal contours were drawn by means of the Klaatsch contour tracer, using the screw-on attachment first adopted by Morant*. The method described by Benington† was followed, with the additions made by later workers in the Biometric Laboratory.

(*a*) *The Transverse Vertical Section.* The method of constructing the mean transverse vertical type contours is described in *Biometrika*, Vol. XIV. p. 227, and the mean measurements from which they were drawn are given in our Table XIII. The right (*R*) and left (*L*) of Table XIII correspond with the right and left of the diagrams which show the transverse contour in Figs. I and II.

The type zone, which is a representation of the limits of variation due to random sampling, is obtained by plotting points at either side of each mean ordinate at a distance from it of twice its Probable Error. It is given by Benington‡ for 100 English skulls as 1·4 mm. at the apex tapering down to 0·8 mm. by the auricular points. The Farringdon Street transverse type contours are based on an average of 75 males and 67 females, and since the width of the type zone is inversely proportional to the square root of the number of skulls, the width of

* *Biometrika*, Vol. XVI. p. 73.
† *Biometrika*, Vol. XI. p. 129.
‡ *Biometrika*, Vol. VIII. pp. 143, 145, 147.

their type zones will be 1·6 mm. at the apex and 0·9 mm. by the auricular points for the male type and 1·7 mm. at the apex with 1·0 mm. at the auricular points for the female type contours. The type zones are not drawn on the accompanying diagrams as it would tend to lack of clearness.

Transverse vertical contours were drawn of the male Whitechapel skulls by Benington, but he did not mark *ZR, R* and *ZR, L*, the points where the zygomatic ridges are crossed, and the auricular points have been joined directly to the extremities of the parallels 2, 3, 4, etc.*, thus giving no indication of the curvature above the auricular point. Also his section shows the frontal view and must be reversed when the tracings are placed over the drawings of the posterior view of the Farringdon Street type.

TABLE XIII.

Mean Values of Transverse Vertical Contours.

Sex	No.	*MA*	1*R*=1*L*	*M*¼*R*	*M*¼*L*	2*R*	2*L*	3*R*	3*L*	4*R*	4*L*	5*R*	5*L*	6*R*	6*L*
♂	75	110·0	58·6	61·5	61·0	64·0[a]	62·5	67·6[b]	66·0[c]	69·5[d]	67·7[e]	69·5[a]	67·4[c]	68·1[c]	66·3[e]
♀	67	103·0	53·9	57·7	56·3	60·1[g]	58·7	63·5[h]	61·6[h]	65·5[h]	63·5[l]	65·4[h]	63·5[j]	63·9[g]	61·9[g]

Sex	No.	7*R*	7*L*	8*R*	8*L*	9*R*	9*L*	10*R*	10*L*	*A*¼*R*	*A*¼*L*	*ZR, R*		*ZR, L*	
												y	*x*	*y*	*x*
♂	75	65·7[c]	63·4[f]	61·4[c]	58·8[e]	53·0	50·3	38·7[f]	36·3	19·6[f]	18·1	61·8	1·9	61·2	3·0
♀	67	61·9[g]	59·7	57·4[g]	55·7	49·7[g]	48·0	36·2[g]	34·0	17·7[g]	17·1	57·6	2·1	56·5	3·0

a = mean of 71 contours		*f* = mean of 74 contours	
b = „ 70 „		*g* = „ 66 „	
c = „ 73 „		*h* = „ 65 „	
d = „ 67 „		*j* = „ 64 „	
e = „ 72 „		*l* = „ 63 „	

If this superposition is made so that the inter-auricular lines coincide, the two types are found to be very similar. There is a slight tendency on the part of the Farringdon Street contour to come inside the Whitechapel, but it is only significant in the region of the apex. Actually at *A* the divergence is 1·8 mm. On the left the divergence is 1 mm. at the 7th parallel and increases slightly up to the apex, but nowhere on the right is it as great until $A\frac{1}{4}$, and it is only in these regions that the type zones fall outside one another. On the right side they are almost coincident.

The type contours, then, confirm the difference in height suggested by the mean measurements.

The greatest breadth shown by the contours is 137·2 mm., which is 5·2 mm. less than the mean parietal breadth of the Farringdon Street crania and 3·5 mm.

* *Biometrika*, Vol. XIV. p. 231.

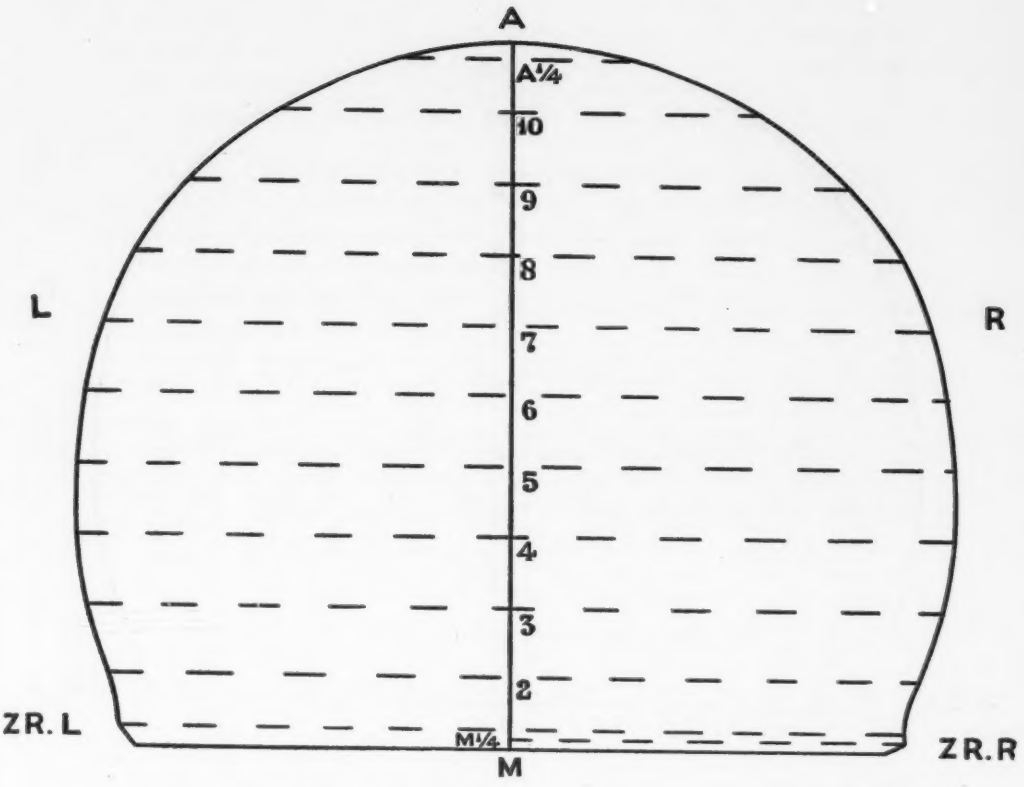

FIG. I 17th Century Londoners ♂ Transverse Type Contour.

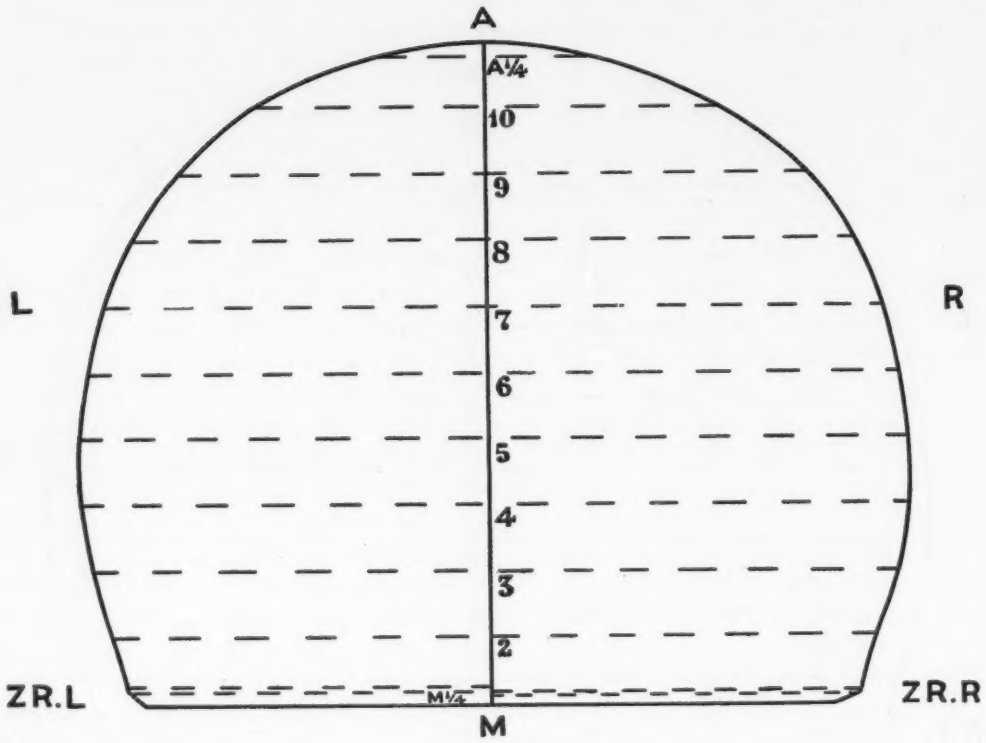

FIG. II 17th Century Londoners ♀ Transverse Type Contour

less than the Whitechapel. Such a defect is just what we should expect, since the vertical section through the auricular points is usually in front of that through the greatest parietal width. The range of this defect has been observed in other series to be from 3·5 to 6·0 mm.

The auricular height, *MA*, in both types is identical with the *OH* of the mean direct measurements, although the *A* of the individual contours might, as we have drawn *MA* as the perpendicular bisector of the inter-auricular length, be not the same point as the "apex" to which the *OH* measurement is taken.

Unfortunately no contours have been drawn of the females of the Whitechapel series.

If the Farringdon Street female type contour is placed on the male, so that the 6th parallels are coincident, it will be observed that the two are very much alike in shape.

The difference between them is merely one of size.

The greatest breadth of the female type contour is 130 mm., that is, 5·7 mm. less than the mean direct measurement.

All three contours show a slightly greater development on the right side, a characteristic more marked in the Farringdon Street than in the Whitechapel series.

Table XIV gives the inter-auricular length and auricular height, together with the index, for the Farringdon Street series. The Whitechapel contour is not drawn into the ear passage, so that an accurate determination of the inter-auricular length is not possible.

TABLE XIV.

Measurements on Transverse Type Section.

	Sex	Inter-auricular Length	Auricular Height	Index
Farringdon Street	♂	117·2	110·0	93·8
,, ,,	♀	107·8	103·0	95·6

(*b*) *The Glabella Horizontal Section.* The method of drawing the horizontal type contour is described in *Biometrika*, Vol. XIV. p. 234; the additional parallels $2\frac{1}{2}R$ and $2\frac{1}{2}L$*, introduced later, were drawn. These enable us to determine the curvature behind the temporal lines more accurately. The mean measurements from which the type contours were constructed are given in Table XV.

The diagrams (Figs. III and IV) show the vertical aspect and their right and left are the right and left of Table XV.

Benington's horizontal type zone for 100 skulls has an approximate width of 1·2 mm. all round. In the Farringdon Street series 72 male and 65 female contours were drawn, so that their type zones should have widths of 1·4 and 1·5 mm. respectively.

* *Biometrika*, Vol. XIV. p. 82.

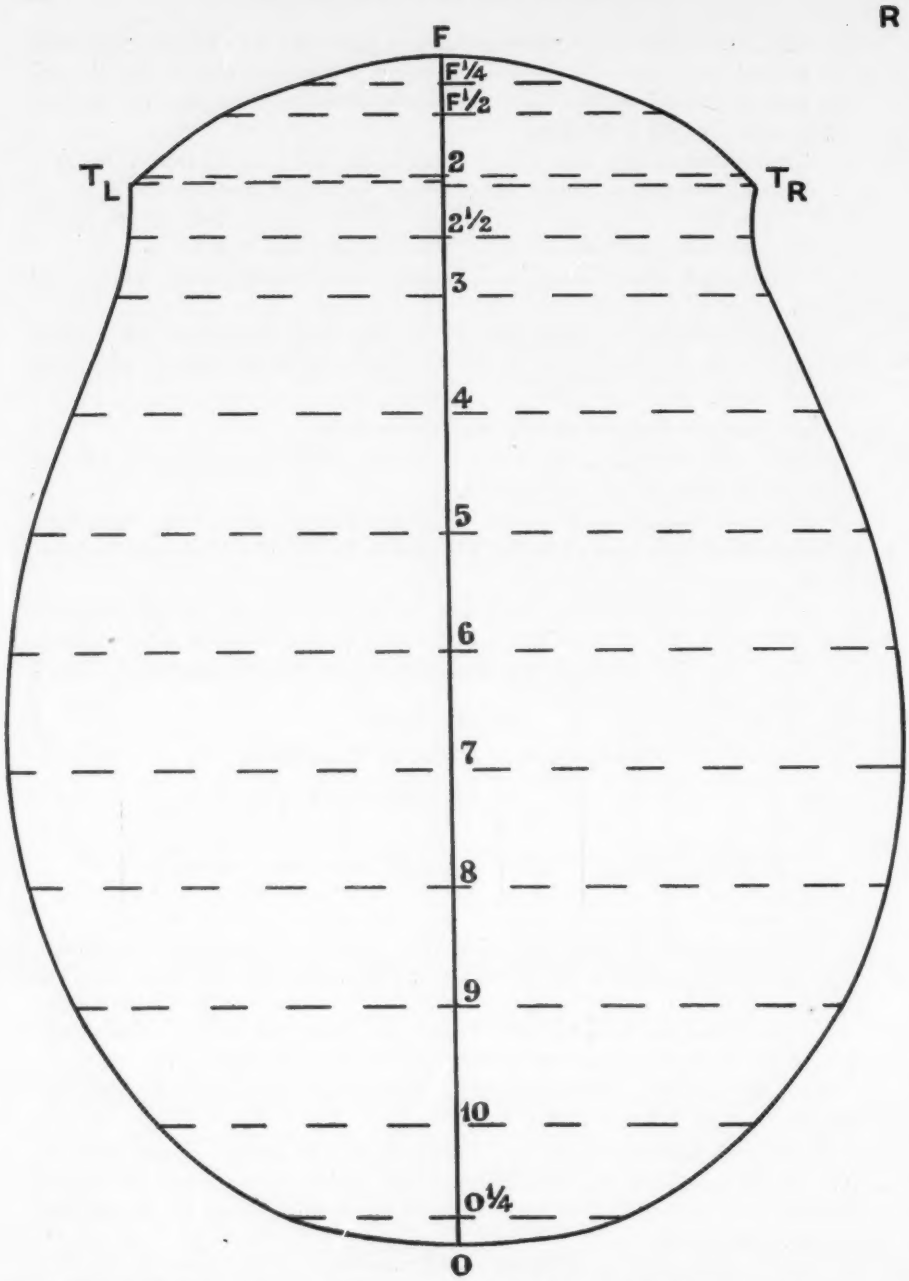

FIG. III 17th Century Londoners ♂ Horizontal Type Contour

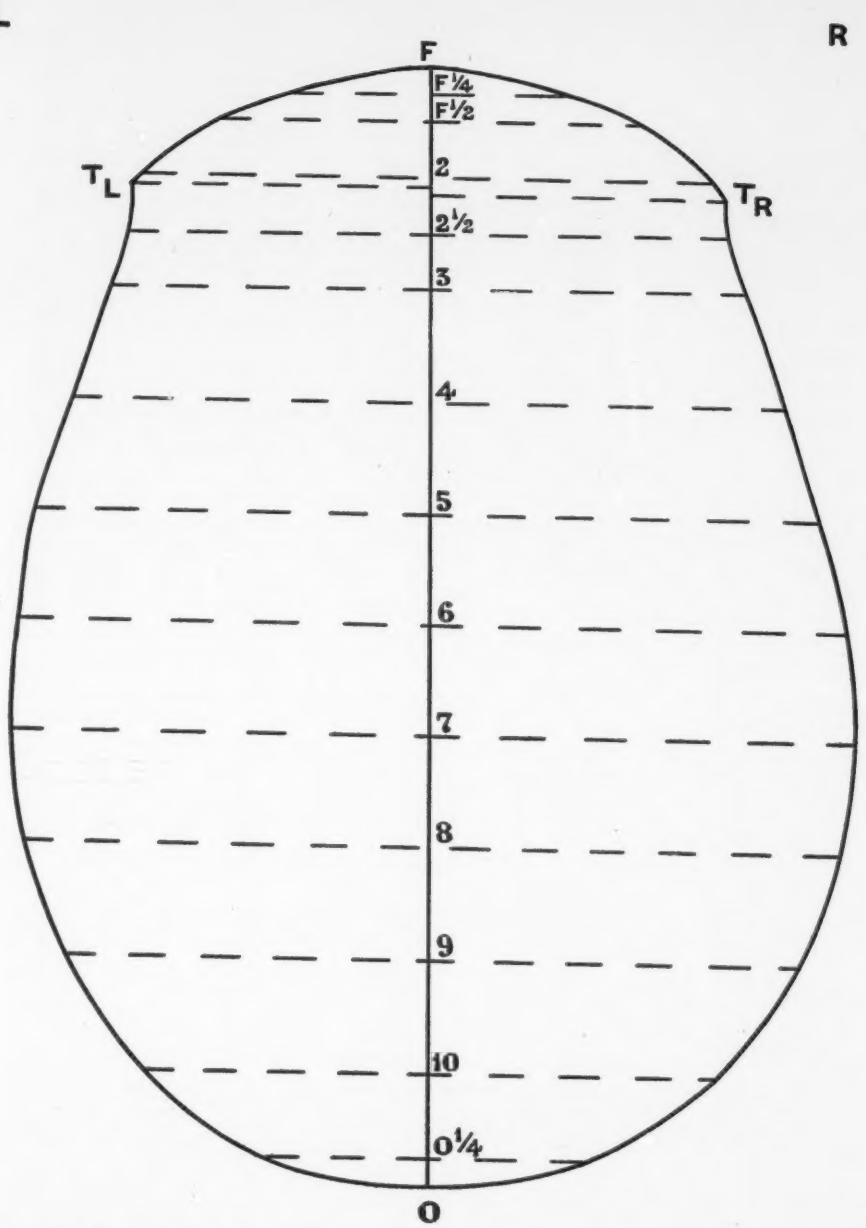

FIG. IV 17th Century Londoners ♀ Horizontal Type Contour.

The points *T*, *R* and *T*, *L*, where the temporal lines are crossed, were not marked on the Whitechapel horizontal contours, thus giving the frontal region a rounded appearance and making a comparison with that part less valuable.

If the Whitechapel horizontal contour is superposed on the Farringdon Street so that the axes *FO* and the points *F* coincide, it will be noticed that the lengths are practically identical. The width from the 5th to the 8th parallels is also the same, and then the Whitechapel curves in more rapidly to the occipital region, this being more pronounced on the right side than on the left. From the 8th

TABLE XV.

Mean Values of Horizontal Contours.

Sex	No.	*FO*	*F*¼*R*	*F*¼*L*	*F*½*R*	*F*½*L*	2*R*	2*L*	2½*R*	2½*L*	3*R*	3*L*
♂	72	185·8	22·6	21·6	35·4	34·6	46·5	47·0	47·7	49·1[a]	50·7[b]	51·2[c]
♀	65	174·8	22·1	21·4	33·3	33·1	44·3	44·9	46·5	46·9	49·4[k]	50·0[k]

Sex	No.	4*R*	4*L*	5*R*	5*L*	6*R*	6*L*	7*R*	7*L*	8*R*	8*L*	9*R*
♂	72	58·6[d]	58·4[e]	65·9[e]	65·0[e]	69·8[f]	68·4[g]	70·5[b]	69·2[g]	67·9[a]	66·4	60·6[a]
♀	65	55·5[k]	55·7[l]	61·0[k]	61·7[l]	65·3[k]	64·0[k]	66·4	65·3[k]	64·1	62·9	57·7

Sex	No.	9*L*	10*R*	10*L*	*O*¼*R*	*O*¼*L*	*T*, *R*		*T*, *L*	
							x	*y*	*x*	*y*
♂	72	59·6	46·7	46·4	26·2	27·2	20·4	48·9	19·9	48·7
♀	65	56·6	44·8[k]	44·6	24·8	25·5	20·6	46·2	18·7	46·4

a = mean of 71 contours
b = „ 69 „
c = „ 68 „
d = „ 66 „
e = „ 65 „
f = mean of 67 contours
g = „ 70 „
k = „ 64 „
k = „ 63 „
l = „ 62 „

parallel to the 10th on the right and at the 10th on the left, the type zones fail to overlap. This confirms our deductions from the mean direct measurements, namely, that the parietal width is greater in the Farringdon Street series.

In front of the 5th parallels the Farringdon Street type narrows more rapidly than the Whitechapel and at the 3rd parallels the divergence is 4·5 mm. on the right and 3·5 mm. on the left.

In front of the temporal lines, the coincidence is again marked.

The differences between the two series are more clearly indicated in these contours than in the transverse vertical type.

The female type may be compared with the male as before, by placing the tracing over the drawing so that the *FO* axes and the 6th parallels are made to coincide, and again the marked similarity in shape is noted.

If the ordinates of the points where the temporal lines are crossed are superposed as nearly as possible, it will be observed that the curvatures of the foreheads are very much the same.

The Temporal Indices and Indices of Frontal Flattening are given in Tables XVI and XVII.

TABLE XVI.

Measurements on Horizontal Type Section.

	Sex	Temporal Index	$100 \frac{\text{Ordinate 3}}{\text{Minimum Forehead Breadth}}$
Whitechapel ...	♂	58·8	111·6
Farringdon Street	♂	54·8	104·1
,, ,,	♀	56·8	106·9

The temporal index is formed by expressing the total length of ordinate 3 as a percentage of the length *FO*. The Whitechapel series are better developed in the fronto-temporal regions, and the females of the Farringdon Street series more so than the males.

TABLE XVII.

Index of Frontal Flattening of Farringdon Street Crania.

	$\frac{1}{2}[TR(x)+TL(x)]$	Length of Section (*FO*)	$\frac{100 \times \frac{1}{2}[TR(x)+TL(x)]}{FO}$
Males	$\frac{1}{2}(20{\cdot}4+19{\cdot}9)=20{\cdot}15$	185·8	10·8
Females	$\frac{1}{2}(20{\cdot}6+18{\cdot}7)=19{\cdot}65$	174·8	11·2

(*c*) *The Sagittal or Median Section.* The construction of the sagittal type contour is given in *Biometrika*, Vol. XIV. pp. 239 and 240. The actual measurements used are given in Table XVIII. The abbreviations used in the table and diagrams are:

N = Nasion. *G* = Glabella. *Bas.* or *B* = Basion. β = Bregma. *V* = Vertex. *A* or *Alv.* = Alveolar point. *Sub-Orb.* = Left infra-orbital point. *Aur.* = Auricular point. *I* = Inion. *Op.* = Opisthion. *Sp.* = Sphenoidal point, i.e. the point of intersection of the median plane and the suture between the sphenoid and basi-occipital bones. *P* = point of intersection of the palatine sutures. *P'* = Extremity of *spina nasalis posterior*. *NS* = Extremity of anterior nasal spine. *L* = Tip of nasal bone. *L'* = Point at which *NL* first meets the outline of the nasal bone.

Benington's Whitechapel section has a type zone of 1·6 mm. from the glabella to λ tapering to 0·7 mm. at gamma and 0·9 at the nasion. This section was only

TABLE XVIII. *Means of Contour Measurements used in plotting Sagittal Type Contours.*

Sex	No.	$N\gamma$	Ordinates above $N\gamma$														
			$O=N$	$N\frac{1}{4}$	1	2	3	4	5	6	7	8	9	$\gamma\frac{1}{4}$	$\gamma\frac{1}{2}$	$\gamma=10$
♂	71	184·3	20·0	33·0	53·6	66·2	74·5	78·9	80·2	80·6	77·6	68·7	52·5	23·6	14·9	4·3
♀	64	174·9	17·2	32·4	50·6[b]	61·5[b]	68·3[b]	72·1[b]	74·5	75·5[b]	72·6	65·0	47·2	22·0	15·7	5·1

Sex	No.	Ordinates below $N\gamma$								Vertex		β		Glabella		Occipital Point		λ		Sub-Orb.	
		$O=N$	$N\frac{1}{4}$	1	2	8	9	$\gamma\frac{1}{2}$	$\gamma\frac{1}{4}$	x from N	y	x from N	y	x from N	y	x from γ	y	x from γ	y	x from N	y
♂	71	64·4[a]	63·8[d]	56·6[f]	54·2[g]	48·2	40·0	31·3	21·6	102·1	81·5	79·3	79·5	2·6	9·8	0·4	1·2	5·7	24·3	10·0	30·3
♀	64	59·6[c]	57·2[e]	52·1[g]	50·4[h]	45·8	26·7	28·1	21·0	97·3[b]	76·0[b]	75·8	73·0	1·1	10·9	0·3	0·9	4·5	22·0	8·3	29·1

Sex	No.	Aur.		Op.		Inion		Basion		Alv. Pt.		Nose					Palate			
															Max. Sub.		P'		P	
		x from γ	y	x from γ	y	x from γ	y	from N	from γ	from N	from Bas.	NL	NL'	$\angle LN\gamma$	x from N	y	x from N	y	x from A	y
♂	71	96·8	30·1	61·8	53·5	18·1	41·6	99·6[k]	109·7[k]	70·8[l]	93·3[p]	24·2[r]	21·3[r]	124°·8[r]	3·0[r]	9·3[r]	46·3[s]	53·0[s]	15·6[m]	34·3[m]
♀	64	92·0	29·1	58·4[a]	52·4[a]	18·0[a]	37·9[a]	94·3[a]	104·0[a]	65·7[m]	88·6[q]	21·3[s]	19·6[s]	122°·2[s]	2·8[s]	8·8[s]	41·2[t]	49·3[t]	32·9[m]	14·6[m]

Sex	No.	Frontal Max. Sub. to $N\beta$		Occipital Max. Sub. to λ Op.		Max. Sub. to $N\lambda$		Max. Sub. to GI		Sp.		Sub. from $\frac{1}{2}$ Bas. Sp. Chord		N. S.		Max. Sub. of Alv. N. S. Arc	
		x from N	y	x from λ	y	x from N	y	x from G	y	x from N	y	x from Bas.	y	x from N	y	x from N	y
♂	71	46·7[k]	25·5[k]	50·1	30·1	86·5	68·6	105·4	103·6	65·4[k]	32·7[k]	12·9[k]	1·1[k]	6·1[l]	51·6[l]	3·1[l]	57·8[l]
♀	64	42·7[b]	24·9[b]	42·4[a]	26·5[a]	83·1[a]	63·9[a]	99·9[a]	96·2[a]	62·0[a]	32·8[a]	11·4[a]	0·6[a]	6·0[p]	47·5[p]	3·7[v]	52·9[b]

a=mean of 62 contours
b= ,, 63 ,,
c= ,, 60 ,,
d= ,, 67 ,,

e=mean of 59 contours
f= ,, 69 ,,
g= ,, 61 ,,
h= ,, 57 ,,

k=mean of 70 contours
l= ,, 54 ,,
m= ,, 52 ,,

p=mean of 53 contours
q= ,, 50 ,,
r= ,, 16 ,,

s=mean of 26 contours
t= ,, 56 ,,
v= ,, 58 ,,

d= „ 67 „ h= „ 57 „

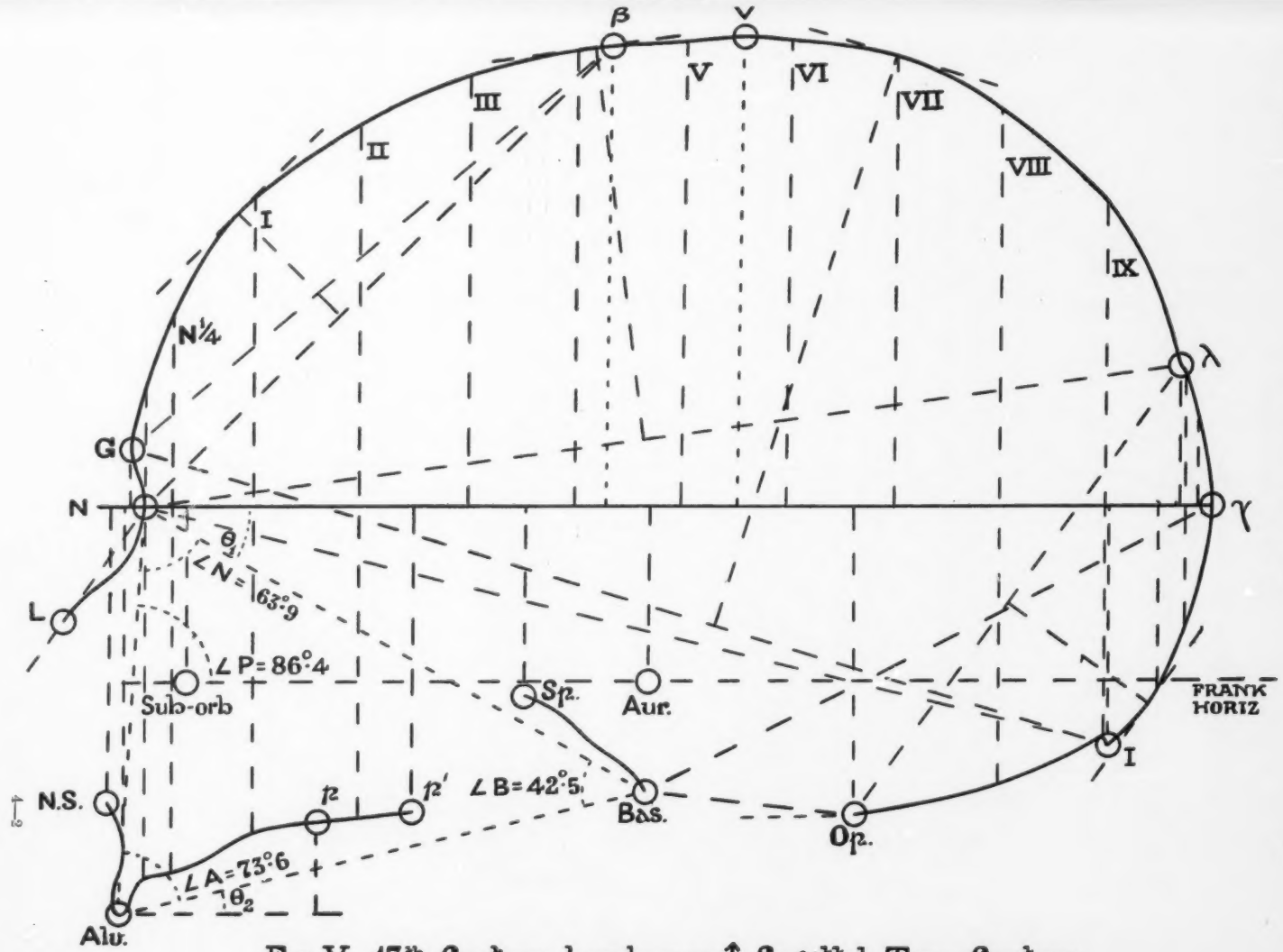

FIG. V 17th Century Londoners ♂ Sagittal Type Contour.

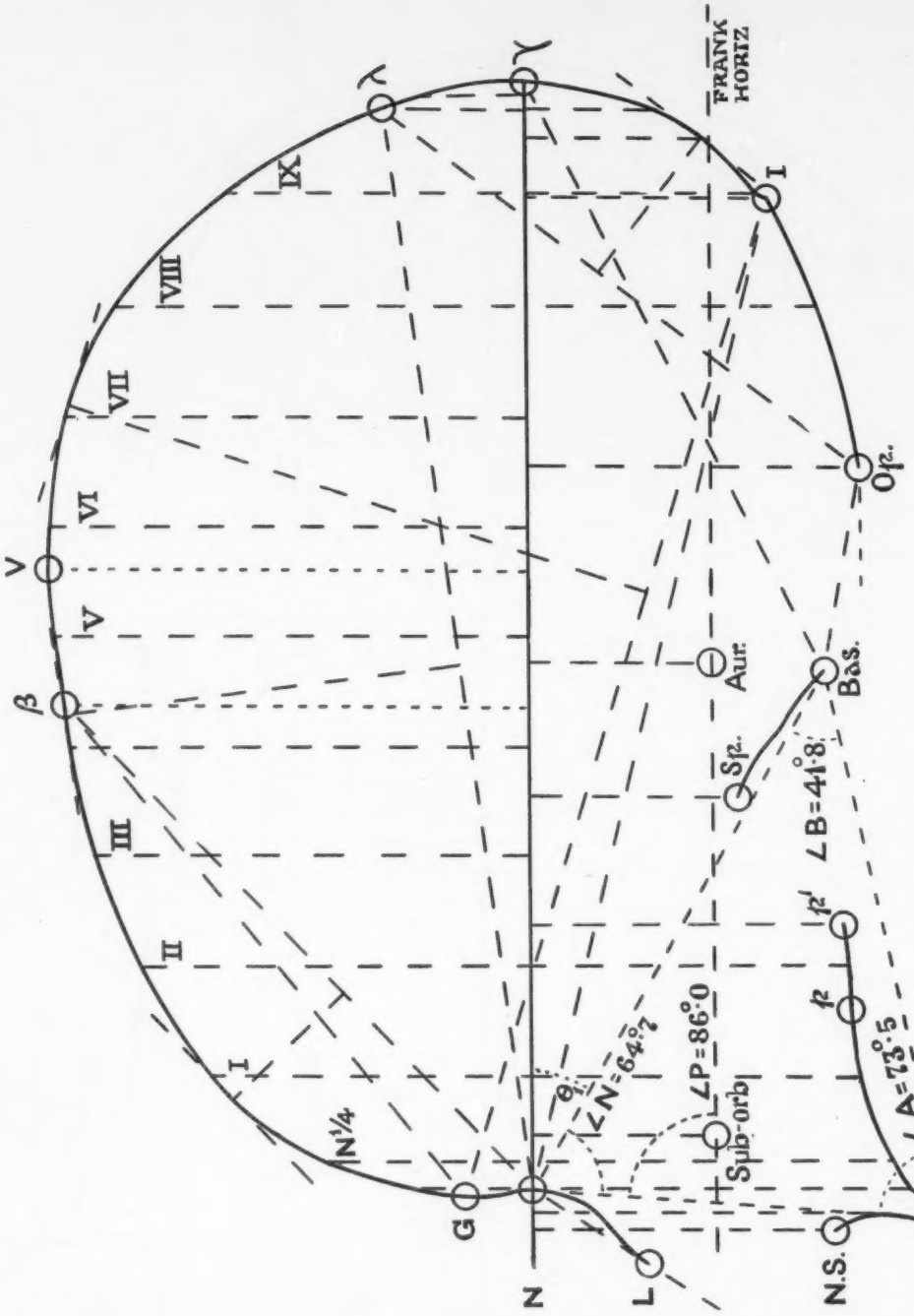

FIG. VI 17th Century Londoners ♀ Sagittal Type Contour.

drawn from the nasion to the gamma. The widths for the Farringdon Street type zones for 71 males and 64 females are tabled below.

Width of Type Zone in mm.

Sex	Nasion	Vault	Gamma
♂	1·1	1·9	0·8
♀	1·1	2·0	0·9

From the sagittal section we see that the Farringdon Street crania are characterised by rather low, receding forehead, a distinct glabella, well-developed occiputs, and pronounced inions.

If the Whitechapel type contour be superposed on the Farringdon Street so that the $N\gamma$ axes coincide, the equality in length observed in the horizontal contours is again evident, and the discrepancies in height indicated by the transverse vertical type are also confirmed. The bregma of the Whitechapel type is slightly in advance of the Farringdon Street β, and both are between the 4th and 5th parallels, rather nearer to the 4th as has been observed in other cranial types. The vertex of the Whitechapel contour is directly above that of the Farringdon Street, both being slightly nearer to the 6th than to the 5th parallel.

In the frontal area the two types are identical, the Whitechapel beginning to rise above the Farringdon Street at the parallel $N\frac{1}{4}$.

The type zones just fail to overlap from the 3rd to the 8th parallels, the divergence being somewhat greater behind the vertex.

While the tracings are in this position, the distance of the Whitechapel bregma from the Farringdon Street basion is 132·8 mm. The mean value of the direct measurements give the Whitechapel crania a basio-bregmatic height of 132·7. Again the length from nasion to basion is 100 mm. for the Farringdon Street and 101·6 mm. for the Whitechapel. This suggests that the basion of the Whitechapel series would be on a level with and slightly behind that of the Farringdon Street. The height of the Whitechapel vertex above the sub-orbital-auricular line is 114·5 mm. as compared with 112·1 mm., the mean of the direct measurements. We may suppose, then, that the corresponding line on the Whitechapel type contour would lie from 2 to 3 mm. higher than the same line on the Farringdon Street sagittal section.

If now the tracing is turned so that the $N\beta$ lines coincide, the similarity between the two contours is even more striking. Not only are N and β similarly placed on both types but it will be observed that the λ of the Whitechapel type is extremely close to the λ of the Farringdon Street.

The sagittal arcs were not measured in the former series, but we may safely conclude that S_1, S_2, S_1' and S_2' do not differ significantly in the two series. The mean values of the complete sagittal arcs are 378·8 mm. for the Farringdon Street

FIG. VI. 17th Century Londoners ♀ Sagittal Type Contour.

and 377·1 mm. for the Whitechapel crania, so we may infer that the arc from λ to opisthion is slightly greater in the Farringdon Street crania.

A discrepancy is noted in the relative positions of γ, the difference between them being 6 mm.

It is very unfortunate that a comparison of the occipital regions and of the palates cannot be made.

When the contours are placed with the $N\beta$ line as base, there is no portion which is not covered by the type zone.

The female sagittal type contour shows the same low receding forehead exhibited by the male. They can be compared by placing the tracing of the female type over the drawing of the male, with the $N\gamma$ line as base and 4·7 mm. between the two nasions, since the total difference in length is 9·4 mm., and as in the other sections the two are seen to be very similar in shape.

The male is more developed immediately in front of the bregma and also in the occipital region, as would be expected. The glabella of the female section is less marked than is the case in the male.

The palates, and indeed the whole of the contours from NS to P', are extremely alike in shape and size, the palate length of the female being a little shorter.

In Table XIX we give the physiognomic angle of flatness of the three types. The values are very close and are low compared with other races for which this measurement has been taken.

TABLE XIX.

	Sex	Angle of Frontal Bone Flatness	Bregmatic Angle	Physiognomic Angle of Flatness
Farringdon Street	♂	28·9	45·2	74·1
" "	♀	30·5	44·0	74·5
Whitechapel ...	♂	26·6	47·1	73·7

Conclusion.

The characteristics exhibited by the Farringdon Street crania confirm those already attributed by Dr Macdonell to the Londoner of the 17th century, as we might have expected from a knowledge of the history of the skulls.

All three series are remarkable for their low retreating foreheads, the Farringdon Street crania having even lower vaults than the Whitechapel, and in this respect they are farther removed from the Long Barrow skulls to which Macdonell traced resemblances in the series he investigated.

In Scotland we find somewhat the same type reproduced in the Lowland Scottish crania, more closely, indeed, than in the mediaeval English skulls as represented by the Hythe and Rothwell series, both of which diverge markedly from the London series.

			Lengths											
No.	Sex	*C*	*F*	*L'*	*L*	*B*	*B'*	*H*	*H'*	*OH*	*LB*	*Q*	*Q'*	*S*
1	♂	—	192	199·5	198·5	147	101	131·5	131	116	104	324	324	385
2	,,	1512·5	181·5	187	186·5	145	96	137	136·5	117	103	323	323	377·5
3	,,	1619·5	192·5	197	195	145	99·5	137	135·5	110·5	108·5	315?	317?	387·5
4	,,	1595·5	199	201	202	149·5	97	133	132	111·4	104·5	311	314	395
5	,,	1602·0	188	195	193	142·5	97·5	137·5	137·5	117·5	104	325	326·5	394
6	,,	1497·5	194·5	197	196	141·5	96	136	135	112	101·5	307	308	406
7	,,	1492·5	190·5	192	191·5	144	105·5	137	134	118·5	102·5	326	326	387
8	,,	1605·5?	194	199	197	154	101·5	133·5	134	121	110	317	323	381?
9	,,	1697·0?	191·5	191	192	148	101·5	128	128	110	97·5	321	325	393
10	,,	1579·0	187	187	187·5	147	97	126·5	127	109·3	97·5	309	314·5	379·5
11	,,	1500·0	176	177	176·5	140	101·5	129	127·5	111·5	91	310	310·5	371
12	,,	—	193	—	196·5	150	101	—	121	—	98	—	—	393
13	,,	1481·0	191·5	196·5	196·5	149	106·5	128·5	126	114	103	317	319	372
14	,,	1432·5	181	183·5	183·5	141	95·5	140	139	114·5	104·5	316	316	375
15	,,	1670·5	186·5	183	186·5	154·5	106	140·5	138·5	113·8	104·5	318	325	376
16	,,	1476·0	187	187	188	142	94	132·5	132	110·5	97?	308	312	391?
17	,,	1590·5	190·5	195	192·5	145	95	139·5	139·5	116·3	105·5	320	322	384·5
18	,,	1725·0	194	199	198	146·5	100	139·5	137	116	104·5	317?	323?	403·5
19	,,	1613·0	189	188·5	189·5	142	99	134	134	111	103	307	313	382·5
20	,,	1524·0	193	196	195·5	146	101	123·5	122	111	98	312	315	391
21	,,	1345·0	179	179	180	144	102	127	125·5	115·5	99·5	300	304	354
22	,,	1557·5	195·5	188·5	189	146·5	102	128	127	115·7	99·5	323	326	394
23	,,	1632·5	184	187	185	149	104	130·5	130	113	97·5	324	329	382·5
24	,,	1406·0	185	188	187·5	141·5	95	128	127·5	110·4	98	308	314	371
25	,,	1726·5	191	193	191·5	145·5	94	136·5	136	120·5	102·5	330	333	395
26	,,	—	187·5	190	188	149?	98	124·5	123·5	112·5	97·5	320?	325?	374
27	,,	1477·0	198·5	202·5	201·5	136	97	131·5	130·5	106·3	103·5	295	298	395·5
28	,,	1296·5	182·5	191	190	134·5	85·5	128·5	127·5	107·2	102	297	297	369
29	,,	—	187	191	189·5	142	101	126·5	130	104	99·5	296?	301?	368
30	,,	1385·5	182	192	190·5	138	93	129·5	127·5	103·5	104	289	290	359
31	,,	1359·0	180·5	181	181	140	100·5	129	127·5	106	90·5	298	302	376
32	,,	1600·5	190	193	193·5	143·5	96·5	129	129	111·5	97·5	303	309	386
33	,,	1521·5	182	186·5	185	144·5	99·5	132	131	110·3	101·5	309	313	370
34	,,	1411·0	186·5	193	192·5	135·5	90·5	129·5	130·5	112·4	100	283	287	379
35	,,	1502·5	185	193·5	193	140·5	95	128·5	128·5	107	99	299	301	383
36	,,	1314·0	184	189·5	188·5	130·5	93·5	134	132	112·4	103·5	301	300	375·5
37	,,	1309·0	182·5	186	185	137·5	100·5	130·5	131	109·5	105	308	308	367
38	,,	1627·0	194	200	197·5	142·5	103	138·5	138	115·3	103	313	315	403
39	,,	—	190·5	193·5	193·5	144·5	98	129·5	129·5	107	96	300	304·5	394
40	,,	1478·5	185·5	184·5	185·5	142·5	102	133	133·5	114·4	104	318	321·5	372
41	,,	1470·5	184	187·5	187	146	105	126	124·5	108·3	104·5	311	312	370
42	,,	1519·0	185·5	184·5	184	148	97	136	137	114·7	97	319	324	383·5
43	,,	1398·0	179·5	183	183·5	148	96·5	132·5	131·5	109·5	100·5	312?	315·5?	372
44	,,	1292·5	180·5	188	187	137·5	87·5	122·5	122	105·3	104·5	293	297·5	358
45	,,	—	178	182	181	143·5	96·5	133	132	112·7	95·5	320?	320?	387
46	♂?	—	183·5	189	187	136	98·5	127·5	128	106	101·5	298?	302?	368

Arcs										Face							
Q	*Q′*	*S*	S_1	S_2	S_3	S_1'	S_2'	S_3'	*U*	*PH*	*G′H*	*GB*	*J*	*NH′*	*NH R*	*NH L*	*NB*
324	324	385	127	130	128	115	117·5	102	544	21·0	74·3	104·5	140	52·5	54·2	54·1	27·1
323	323	377·5	132·5	135	110	116·5	121·5	90	529	17·1	66·1	83·6	—	49·0	51·9	51·0	27·5
315?	317?	387·5	135	120	132·5	118	107	105	542	16·9	74·2	95·0	133	57·9	56·4	59·5	27·5
311	314	395	137·5	133·5	124	119·5	122	92	557	22·8	76·0	—	—	51·5?	53·0	52·5	—
325	326·5	394	140	136	118	121	121	99	534	21·0	71·0	96·5	—	52·6	51·1	50·9	27·0
307	308	406	137	138	131	118·5	120	100	541	18·5	77·0	90·5	127·5	56·9	57·5	58·4	26·5
326	326	387	134	130	123	116	117	95	540	20·6	73·1	98·5?	137·5	52·8	54·9	55·0	24·0
317	323	381?	130	120?	131	114	111?	101	556	15·2	71·5	94·1	—	56·0	56·4	55·5	25·1
321	325	393	135	136?	122?	114	121·5?	92·5?	550	—	—	88·1	130	55·0	55·8	55·3	24·8
309	314·5	379·5	126·5	118	135	109	108	108	536	21·0	70·5	85·5	130	49·5	50·9	51·0	23·7
310	310·5	371	123	144?	104	104	122?	91	510	22·2	76·0	91·2	132·5	53·0	54·5	53·5	24·4
—	—	393	134	128	131	116	117·5	94	544·5	—	—	—	—	—	—	—	—
317	319	372	128·5	116·5	127	115·5	119·5	104·5	557	14·3?	59·0?	—	—	44·4	—	46·5	—
316	316	375	131	127	117	114·5	114	100·5	516	—	—	—	—	47·1?	50·3	51·1	24·7
318	325	376	128	129·5	118·5	110	118	91	544	—	73·9	99·4	142·5	—	54·1	54·1	25·7
308	312	391?	130?	137	124	110·5?	120	97	530	—	—	87·1	—	51·9	54·5	55·0	27·7
320	322	384·5	136	128·5	120	119	117	100	540?	21·0	80·0	81·4	—	59·1	59·1	59·5	23·7
317?	323?	403·5	134·5	134	135	118	118	106·5	549	—	70·3	88·0?	135	—	51·5	52·6	23·7
307	313	382·5	133	125	124·5	115·5	112·5	101	534	23·1	80·0	93·5	130·5	56·6	59·0	59·0	23·7
312	315	391	125	134	132	111	119	93	551	15·0	73·8	96·1	135·5	57·7	55·5	57·0	26·0
300	304	354	116·5	123	114·5	103	110	90·5	517·5	23·8	74·2	88·0	—	49·9	49·5	48·3	24·1
323	326	394	128	140	126	111·5	127	96·5	552	19·1	73·0	92·9	—	53·8	54·0	53·3	27·1
324	329	382·5	133·5	129	120	115	111·5	100	537	17·1	77·1	—	—	59·1	58·5	58·0	22·1
308	314	371	129	120	122	114	110	98	522	23·5	69·6	86·0	128	46·0	48·5	47·0	25·1
330	333	395	141	131	123	119	117·5	99·5	543	19·0?	67·5	87·6	—	49·0?	51·0	52·0	24·1
320?	325?	374	135	131·5	107·5	115·5	118	87	528	—	—	82·2	—	48·2	47·3	48·8	24·1
295	298	395·5	137	126·5	132	114	113·5	101·5	540	11·7	67·1	108·9	131·5	55·5	54·2	54·2	27·1
297	297	369	126·5	128	114·5	113·5	116·5	94·5	515·5	14·0	67·0	—	—	53·9	53·1	51·7	24·1
296?	301?	368	127	116	125	117·5	117	97·5	528·5?	16·0?	62·0	99·0	—	47·1	47·5	46·8	28·1
289	290	359	117	117	125	115·5	118	102	520	—	—	93·1	133	49·0	52·0	52·0	25·1
298	302	376	132	128	116	113	113	96	522	21·5	70·3	97·0	—	50·0	50·7	49·5	23·1
303	309	386	136	129	121	118	113	96	540·5	20·0	75·0	90·9	—	59·5	56·5	54·3	22·1
309	313	370	126	123	121	110·5	110·5	100	526	19·1	68·1	82·5	131	48·6	49·0	50·0	25·1
283	287	379	131	130	118	116	113	99	528·5	16·0?	62·8?	89·9	129·5	48·5	47·5	47·6	23·1
299	301	383	122	138	123	110·5	119·5	104	531·5	15·0	65·1	90·0	131·5	50·2	53·2	51·8	26·1
301	300	375·5	119	132	124·5	118·5	116	101	509	21·1	70·0	99·0	127·5	51·3	47·1	47·5	20·1
308	308	367	125	118	124	119·5	107·5	98	520·5	—	—	82·8?	132	52·0	56·1	53·6	28·1
313	315	403	132	132	130	117	113	107	552·5	19·0	68·0	97·2	135?	48·2	51·6	52·3	—
300	304·5	394	130	130	134	114·5	112·5	102·5	540	—	—	—	137	—	—	—	—
318	321·5	372	131	131	110	112·5	117·5	90	523·5	—	—	—	—	—	54·1?	—	—
311	312	370	122	130	118	111	115	95·5	536	21·0	71·4	91·0	137·5	50·4	51·0	51·2	25·1
319	324	383·5	133	126	124·5	114	113	99	530	19·0?	72·8	97·2	—	53·5	53·1	51·8	22·1
312?	315·5?	372	127	125	120	113	109·5	91·5	527·5	22·0	72·0	—	—	51·1	51·1	49·5	23·1
293	297·5	358	124	114	120	111	104·5	94	515·5	16·6	68·8	97·0	128	52·5	53·1	53·1	25·1
320?	320?	387	131	132	124	115	114·5	96·5	516	20·0?	71·1	94·1	—	50·5	51·0	51·9	24·1
298?	302?	368	119	123	126	105	113·5	98	517?	19·2	69·3	—	129·5	51·0	50·8	51·5	24·1

TABLE OF ABSOLUTE AND INDICIAL MEASUREMENTS OF

Nose								Orbits						Palate and Profile						Fora
NH R	*NH L*	*NB*	*DS*	*DC*	*DA*	*SS*	*SC*	O_1R	O_1L	O_2R	O_2L	O_1'	*EOW*	G_1	G_1'	G_2	*GL*	*EB*	*EH*	*fml*
4·2	54·1	27·1	13·6	24·5	35·7	4·0	11·0	44·5	43·3	34·4	35·0	42·8	104·2	—	—	—	104·5	—	—	44·3
1·9	51·0	27·5	16·8	23·1	42·8	4·7	8·0	43·5	42·0	35·0	33·8	40·0	98·0	48·9	45·9	35·5	96·6	35·5	8·2	38·0
6·4	59·5	27·5	12·7	22·5	36·0	6·0	13·8	44·4	44·0	33·5	33·5	43·5	100·0	56·0	53·1	—	102·0	—	—	37·8
3·0	52·5	—	15·5?	23·1	40·6	5·3	8·9	45·0	—	34·8	—	40·8	—	—	—	37·8	93·9	37·5	13·9	40·0
1·1	50·9	27·0	15·5	25·5	40·3	6·0	11·5	44·9	43·3	32·9	31·8	42·8	104·0	54·2	50·1	42·0	97·0	42·0	8·6	37·8
7·5	58·4	26·5	11·6	25·0	36·0	3·0	8·4	41·2	41·4	37·6	36·9	37·2	94·5	53·5	50·9	—	97·5	—	—	33·0
4·9	55·0	24·0	14·8	23·1	38·0	5·1	9·9	44·6	44·3	32·0	34·0	40·6	101·1	53·8	49·8	45·1	102·0	45·0	14·5	38·2
6·4	55·5	25·1?	—	—	—	—	—	40·9?	40·5?	34·8	34·6	—	99·8	55·0	52·0	—	101·0	—	—	49·0
5·8	55·3	24·8	—	—	—	4·0	9·9	43·8	43·8	34·6	35·2	—	97·9	—	—	—	—	—	—	35·5
0·9	51·0	23·1	9·9	26·1	37·6	2·2	8·9	43·8	43·1	34·0	33·6	41·2	99·4	49·0	46·0	—	89·8	—	—	37·5
4·5	53·5	24·0	—	23·2	—	—	—	44·2	42·0	35·0	36·0	42·4	102·1	47·5	43·2	40·3	87·3	40·2	14·2	40·5
—	—	—	12·9	22·1	34·8	4·3	10·1	43·0	—	31·5	—	41·0	—	—	—	—	—	—	—	37·0
—	46·5	—	10·3	25·0	36·5	4·1	13·6	—	44·4	—	33·4	41·5	—	—	—	—	102·0?	—	—	32·0
0·3	51·1	24·0	12·7	21·8	37·4	6·7	9·9	41·8	41·8	32·8	32·2	40·5	96·3	—	—	—	—	—	—	36·8
4·1	54·1	25·6	13·1	24·5	36·7	5·3	11·1	45·0	44·2	33·4	34·8	42·8	107·1	48·6	46·0	40·0?	91·5	40·0	14·5?	39·2
4·5	55·0	27·1	—	19·0	—	—	—	42·1	41·5	38·5	37·0	40·0	95·2	—	—	—	—	—	—	35·2
9·1	59·5	23·2	11·2	18·0	30·8	5·2	9·0	43·8	43·1	36·8	38·0	40·8	94·9	54·6	51·0	—	98·5	—	—	37·1
1·5	52·6	23·4	12·6	21·9	32·3	3·4	10·0	42·8	42·1	35·1	33·1	40·0	97·8	48·5	45·9	37·0	91·0	37·0	13·3	36·0
9·0	59·0	23·8	12·8	21·5	34·0	5·1	9·8	41·2	42·0	38·4	38·8	40·9	98·0	50·8	49·0	32·0	94·2	32·0	9·1?	36·4
5·5	57·0	26·9	11·7	24·5	36·0	3·3	9·7	45·0	45·0	37·1	37·9	40·5	103·8	49·0	47·0	—	98·1	—	—	38·0
9·5	48·3	24·5	12·4	23·6	35·8	3·1	6·7	45·0	42·8	33·2	33·9	40·9	103·0	53·5	50·1	—	97·9	—	—	38·0
4·0	53·3	27·0	11·8?	24·8	35·8?	3·4	10·0	45·0	44·9	36·1	36·8	42·9	104·9	—	—	—	97·0	—	—	38·8
8·5	58·0	22·0	13·0	20·0	34·5	5·5	10·0	44·8	—	40·5	39·5	42·0	—	48·2	45·0	33·0	88·4	33·0	15·0	38·6
8·5	47·0	25·0	11·3	24·1	36·0	4·5	9·2	41·8	41·0	32·8	34·0	38·8	98·0	48·0	44·2	37·0	93·9	37·0	12·0	36·2
1·0	52·0	24·3	11·6	22·7	38·1	4·3	10·4	39·4	39·4	36·4?	34·5	37·5	93·2	51·1	47·8	34·6	97·3	34·5	8·4	38·0
7·3	48·8	24·2	13·6?	22·2	36·7	4·7	9·1	42·3	42·0	38·5	38·2	39·5	96·1	47·0	41·1	—	—	—	—	40·9
4·2	54·2	27·1	—	22·1	—	—	—	43·5	42·0	32·1	32·7	40·6	99·8	52·4	48·6	41·6	99·2	41·5	9·0	35·0
3·1	51·7	24·8	—	19·0	—	—	—	38·8	—	28·1	28·7	36·7	—	49·4	47·0	—	97·5	—	—	35·6
7·5	46·8	28·5	—	24·9	—	—	—	—	43·8	34·3	35·0	41·2	—	53·8	51·1	42·0	102·5	42·0	10·1	36·4
2·0	52·0	25·0	13·8?	20·0	36·1?	4·3	8·1	40·1	40·0	32·7	33·2	38·1	94·8	—	—	—	—	—	—	39·6
0·7	49·5	23·0	10·5	20·9	31·8	3·2	8·5	41·5	44·0	35·1	34·6	40·0	100·0	46·0	44·9	—	85·5	—	—	36·1
6·5	54·3	22·0	11·4	19·2	31·8	5·1	9·8	41·0	—	39·1	38·1?	39·5	—	47·5	45·0	39·0	90·0	39·0	13·0	41·8
9·0	50·0	25·0	11·0	25·4	36·0	3·4	8·5	42·5	40·3	30·3	31·0	39·2	97·8	55·4	51·0	42·0	101·0	42·0	14·0	38·0
7·5	47·6	23·0	11·1	20·0	32·0	2·4	8·1	43·0	43·3	32·8	32·8	41·2	98·1	51·6	48·0	39·5	95·4	40·0	7·2?	37·0
3·2	51·8	26·1	11·4	23·2	35·2	3·4	7·8	40·8	41·0	34·1	32·0	39·1	96·9	43·5	40·0	37·9	86·9	37·9	12·0	38·0
7·1	47·5	20·8	12·7	21·0	39·3	4·9	10·0	41·0	41·2	34·0	33·5	36·0	97·0	47·4	44·0	39·8	94·0	40·0	14·2	39·0
6·1	53·6	28·5	16·5?	26·0	47·5	4·3	10·0	44·0	45·0	31·0	31·3	41·1	103·0	53·2?	50·5?	42·5?	—	42·5?	7·1?	31·0
1·6	52·3	—	—	—	—	—	—	—	46·0	39·0	39·9	—	106·2	55·1	50·1	40·0	—	40·0	12·2?	35·8
—	—	—	—	—	—	2·8	7·8	40·1	—	35·5	—	38·5	—	—	—	—	—	—	—	35·2
4·1?	—	—	13·4?	20·8	36·8?	4·9	9·0	43·3	—	35·1	—	42·2	—	50·9	46·2	—	—	—	—	37·1
1·0	51·2	25·5	15·0	25·6	40·3	5·4	13·1	43·0	43·1	34·3	33·6	41·0	101·8	52·5	48·6	—	103·6	—	—	36·3
3·1	51·8	22·0	12·5	23·9	39·1	2·6	10·0	42·0	42·5	32·6	32·2	39·1	98·2	45·0	42·5	—	88·9	—	—	36·7
1·1	49·5	23·0	11·1	24·0	36·8	4·0	9·0	—	41·8	—	31·4	36·0	—	50·0	46·5	42·8	91·7	42·6	10·8	36·9
3·1	53·1	25·7	10·1	20·0	31·0	2·7	7·9	40·2	41·5	31·5	32·1	40·0	96·1	—	—	42·0	105·0	42·0	13·0	34·5
1·0	51·9	24·5	15·6?	22·2	39·9	6·1?	9·0	43·0	43·1	34·1	34·3	41·0	100·1	51·1	47·1	39·5	89·5	39·5	15·0	33·1
0·8	51·5	24·8?	12·7	21·8	36·0	5·6	6·9	—	42·0	—	32·9	38·5	98·2?	50·1	45·8	—	89·8	—	—	34·5

MEASUREMENTS OF THE INDIVIDUAL CRANIA. (LENGTHS IN MILLIMETRES.)

Palate and Profile				Foramen		Indices											
G_2	*GL*	*EB*	*EH*	*fml*	*fmb*	*Oc.I.*	*B/L'*	*H/L'*	*B/L*	*H/L*	*B/H*	*H'/L*	*B/H'*	$\frac{B-H'}{L}$	*G'H/GB*	*NB/NH R*	*NB*
—	104·5	—	—	44·3	—	56·8	73·7	65·9	74·1	66·2	111·8	66·0	112·2	8·1	71·2	50·0	5
35·5	96·6	35·5	8·2	38·0	30·0	57·9	77·5	73·3	77·7	73·5	105·8	73·2	106·2	4·5	79·1	53·0	5
—	102·0	—	—	37·8	27·6	56·5	73·6	69·5	74·4	70·3	105·8	69·5	107·0	4·9	78·1	48·8	4
37·8	93·9	37·5	13·9	40·0	30·5	54·2	74·4	66·2	74·0	65·8	112·4	65·3	113·3	8·7	—	—	
42·0	97·0	42·0	8·6	37·8	31·5	60·6	73·1	70·5	73·8	71·2	103·6	71·2	103·6	2·6	73·6	52·8	5
—	97·5	—	—	33·0	26·4	55·0	71·8	69·0	72·2	69·4	104·0	68·9	104·8	3·3	85·1	46·1	4
45·1	102·0	45·0	14·5	38·2	30·0	55·4	75·0	71·4	75·2	71·5	105·1	70·0	107·5	5·2	74·2	43·7	4
—	101·0	—	—	49·0	34·6	55·3	77·4	67·1	78·2	67·8	115·4	68·0	114·9	10·2	76·0	44·5	4
—	—	—	—	35·5	30·5	54·7	77·5	67·0	77·1	66·7	115·6	66·7	115·6	10·4	—	44·4	4
—	89·8	—	—	37·5	31·3	57·1	78·6	67·6	78·4	67·5	116·2	67·7	115·7	10·7	82·5	45·4	4
40·3	87·3	40·2	14·2	40·5	32·0	66·0	79·1	72·9	79·3	73·1	108·5	72·2	109·8	7·1	83·3	44·0	4
—	—	—	—	37·0	32·5	53·5	—	—	76·3	—	—	61·6	109·8	14·7	—	—	
—	102·0?	—	—	32·0	30·5	59·0	75·8	65·4	75·8	65·4	116·0	64·1	118·3	11·7	—	—	
—	—	—	—	36·8	32·0	63·3	76·8	76·3	76·8	76·3	100·7	75·7	101·4	1·1	—	47·7	4
40·0?	91·5	40·0	14·5?	39·2	34·2	55·2	84·4	76·8	82·8	75·3	110·0	74·3	111·6	8·5	74·3	47·3	4
—	—	—	—	35·2	30·8	55·9	75·9	70·9	75·5	70·5	107·2	70·2	107·6	5·3	—	49·7	4
—	98·5	—	—	37·1	31·9	60·0	74·4	71·5	75·3	72·5	103·9	72·5	103·9	2·8	98·3	39·3	3
37·0	91·0	37·0	13·3	36·0	28·6	56·3	73·6	70·1	74·0	70·5	105·0	69·2	106·9	4·8	79·9	45·4	4
32·0	94·2	32·0	9·1?	36·4	32·0	57·9	75·3	71·1	74·9	70·7	106·0	70·7	106·0	4·2	85·6	40·3	4
—	98·1	—	—	38·0	32·0	53·3	74·5	63·5	74·7	63·2	118·2	62·4	119·7	12·3	76·8	48·5	4
—	97·9	—	—	38·0	32·0	56·4	80·4	70·9	80·0	70·6	113·4	69·7	114·7	10·3	84·3	49·5	5
—	97·0	—	—	38·8	27·6	55·1	77·7	67·9	77·5	67·7	114·5	67·2	115·4	10·3	78·6	50·0	5
33·0	88·4	33·0	15·0	38·6	33·3	60·0	79·7	70·3	80·5	70·5	114·2	70·3	114·6	10·2	—	37·6	3
37·0	93·9	37·0	12·0	36·2	30·1	57·3	75·3	68·1	75·5	68·3	110·5	68·0	111·0	7·5	80·9	51·5	5
34·6	97·3	34·5	8·4	38·0	28·9	57·7	75·4	70·7	76·0	71·3	106·6	71·0	107·0	5·0	77·1	47·6	4
—	—	—	—	40·9	31·0	57·7	78·4	65·5	79·3	66·2	119·7	65·7	120·6	13·6	—	51·2	4
41·6	99·2	41·5	9·0	35·0	29·6	55·2	67·2	64·9	67·5	65·3	103·4	64·8	104·2	2·7	61·6	50·0	5
—	97·5	—	—	35·6	35·0	59·2	70·4	67·3	70·8	67·6	104·7	67·1	105·5	3·7	—	46·7	4
42·0	102·5	42·0	10·1	36·4	29·8	55·8	74·3	66·2	74·9	66·8	112·3	68·6	109·2	8·3	62·6	60·0	6
—	—	—	—	39·6	35·3	58·4	71·9	67·4	72·4	68·0	106·6	66·9	108·2	5·5	—	48·1	4
—	85·5	—	—	36·1	34·1	59·4	77·3	71·3	77·4	71·3	108·5	70·4	109·8	7·0	72·5	45·4	4
39·0	90·0	39·0	13·0	41·8	32·5	56·6	74·4	66·8	74·2	66·7	111·2	66·7	111·2	7·5	82·5	38·9	4
42·0	101·0	42·0	14·0	38·0	31·1	59·3	77·5	70·8	78·1	71·4	109·5	70·8	110·3	7·3	82·5	51·0	5
39·5	95·4	40·0	7·2?	37·0	27·0	60·6	70·2	67·1	70·4	67·3	104·6	67·8	103·8	2·6	69·9	48·4	4
37·9	86·9	37·9	12·0	38·0	31·8	61·4	72·6	66·4	72·8	66·6	109·3	66·6	109·3	6·2	72·3	49·1	5
39·8	94·0	40·0	14·2	39·0	32·1	57·9	68·9	70·7	69·2	71·1	97·4	70·0	98·9	−0·8	70·7	44·2	4
42·5?	—	42·5?	7·1?	31·0	29·3	56·4	73·9	70·2	74·3	70·5	105·4	70·8	105·0	3·5	—	50·8	5
40·0	—	40·0	12·2?	35·8	31·0	55·3	71·3	69·3	72·2	70·1	102·9	69·9	103·3	2·3	70·0	—	
—	—	—	—	35·2	28·5	55·0	74·8	66·9	74·7	66·9	111·6	66·9	111·6	7·8	—	—	
—	—	—	—	37·1	32·0	58·5	77·2	72·1	76·8	71·7	107·1	72·0	106·7	4·8	—	—	
—	103·6	—	—	36·3	32·0	57·7	77·8	67·1	78·1	67·4	115·9	66·6	117·3	11·5	78·5	50·0	
—	88·9	—	—	36·7	32·1	56·7	80·2	73·7	80·4	73·9	108·8	74·5	108·0	5·9	74·9	41·4	
42·8	91·7	42·6	10·8	36·9	30·1	54·9	81·0	72·5	80·7	72·2	111·7	71·7	112·5	9·0	—	45·0	
42·0	105·0	42·0	13·0	34·5	32·1	56·0	73·1	65·2	73·5	65·5	112·2	65·2	112·7	8·3	70·9	48·4	
39·5	89·5	39·5	15·0	33·1	33·0	—	78·8	73·1	79·3	73·5	107·9	72·9	108·7	6·4	75·6	48·0	
—	89·8	—	—	34·5	30·9	55·7	72·0	67·5	72·7	68·2	106·7	68·4	106·3	4·3	—	48·8	

TRES.)

Indices										Angles (in degrees)						
NB/NH R	*NB/NH L*	O_2/O_1 *R*	O_2/O_1 *L*	O_2/O_1'	G_2/G_1	*EH/EB*	*fmb/fml*	*DS/DC*	*SS/SC*	*N ∠*	*A ∠*	*B ∠*	θ_1	θ_2	*P ∠*	
50·0	50·1	77·3	80·8	80·4	—	—	—	55·5	36·4	69·6	69·0	41·4	22·9	18·5	87·5	Cal. br. Slight bath pterygoid plate,
53·0	53·9	80·5	80·5	87·5	72·6	24·5	78·9	72·7	58·8	65·5	76·3	38·2	28·7	9·5	85·8	Cal. P.B. upwards
48·8	46·2	75·5	76·1	77·0	—	—	73·0	56·4	43·5	65·1	75·0	39·9	29·0	10·9	85·9?	Cal. br. P.B. down
—	—	77·3	—	85·3	—	37·1	76·2	67·1	59·6	60·3	75·5	44·2	31·9	12·3	87·8	Cal. – part f. Teet
52·8	53·0	73·3	73·4	76·9	77·5	20·5	83·3	60·8	52·2	64·0	75·1	40·9	25·2	15·7	90·8	Cal. 1 carious tooth
46·1	45·4	91·3	89·1	101·1	—	—	80·0	46·4	35·7	64·5	70·2	45·3	32·7	12·6	82·8	Cal. Slight bathroc
43·7	43·6	71·7	76·7	78·8	83·8	32·2	78·5	64·1	51·5	68·6	69·1	41·3	25·6	16·7	85·8	Cal. Teeth worn. S
44·5	45·2	85·1	85·4	—	—	—	70·6	—	—	63·6	77·4	39·0	27·9	11·1	88·5	Cal. – part f. P.B.
44·4	44·8	79·0	80·4	—	—	—	85·9	—	40·4	—	—	—	—	—	—	Cal. Edentulous. A
45·4	45·3	77·6	78·0	82·5	—	—	83·5	37·9	24·7	61·9	74·3	43·8	33·1	10·7	85·0	Cal. P.B. upwards
44·0	44·9	79·2	85·7	82·5	84·8	35·5	79·0	—	—	62·2	67·4	50·4	32·8	17·6	85·0	Cal. Young adult. T 4 mm. Interpari
—	—	73·3	—	76·8	—	—	87·8	58·4	42·6	—	—	—	—	—	—	Br. cal. – part f. J flattening. Flatt
—	—	—	75·2	80·5	—	—	95·3	41·2	30·1	72·2	74·7	33·1	22·5	10·6	85·3	Cal. – part f. Sligh
47·7	47·0	78·5	77·0	81·0	—	—	87·0	58·3	67·7	—	—	—	—	—	—	Cal. Edentulous. P
47·3	47·3	74·2	78·7	78·0	82·3	36·3	87·2	53·5	47·7	58·8	78·9	42·3	32·7	9·6	88·5	Cal. Teeth worn. P on R. malar very
49·7	49·3	91·4	89·2	96·3	—	—	87·5	—	—	—	—	—	—	—	—	Cal. Edentulous. P
39·3	39·0	82·2	88·2	90·2	—	—	86·0	62·2	57·8	62·0	72·0	46·0	33·2	12·8	84·8	Cal. br. 2 carious t
45·4	44·5	82·0	78·6	87·7	76·3	35·9	79·4	57·5	34·0	58·9	79·8	40·3	29·9	11·4	91·2	Cal. br. P.B. flat w
40·3	40·3	93·2	92·4	93·9	63·0	28·4	87·9	59·5	52·0	60·1	72·3	47·6	35·0	12·6	84·9	Cal. R. 3rd molar d
48·5	47·2	82·4	84·2	91·6	—	—	84·2	47·8	34·0	67·8	67·9	44·3	27·2	17·1	85·0	Cal. Teeth much w
49·5	50·7	73·8	79·2	81·2	—	—	84·2	52·5	46·3	66·4	69·5	44·1	28·8	15·3	84·8	Cal. P.B. upwards
50·0	50·7	80·2	82·0	84·1	—	—	71·1	47·6	34·0	66·3	69·9	43·8	26·7	17·1	87·0	Cal. P.B. upwards
37·6	37·9	90·4	—	96·4	68·5	45·5	86·3	65·0	55·0	59·3	71·9	48·8	30·5	18·3	90·2	Cal. – part f. P.B.
51·5	53·2	78·5	82·9	84·5	77·1	32·4	83·1	46·9	48·9	65·2	72·4	42·4	27·0	15·4	87·8	Cal. P.B. upwards
47·6	46·7	92·4	87·6	97·1	67·7	24·7	76·1	51·1	41·3	65·9	74·5	39·6	26·8	12·8	87·3	Cal. P.B. flat with
51·2	49·6	91·0	91·0	97·5	—	—	75·8	61·3	51·6	—	—	—	—	—	—	Cal. br. Edentulous
50·0	50·0	73·8	77·9	79·1	79·4	22·0	84·6	—	—	67·0	74·4	38·6	26·2	12·4	86·8	Cal. Teeth worn. P
46·7	48·0	72·4	—	76·6	—	—	98·3	—	—	66·7	74·3	39·0	29·4	9·6	83·9	Cal. – part f. P.B.
60·0	60·9	—	79·9	83·3	78·1	24·0	81·9	—	—	74·5	70·0	35·5	31·0	4·5	74·5	Br. cal. – part f. T
48·1	48·1	81·5	83·0	85·8	—	—	89·1	69·0	53·1	—	—	—	—	—	—	Cal. old. Sagittal su tions in tympani
45·4	46·5	84·6	78·6	87·7	—	—	94·5	50·2	37·6	62·6	70·4	47·0	31·9	15·1	85·5	Cal. Teeth good. P
38·9	40·5	95·4	—	99·0	82·1	32·0	77·8	59·4	52·0	61·0	72·0	47·0	30·0	17·0	89·0	Cal. – part f. Teeth
51·0	50·0	71·3	76·9	77·3	75·8	33·3	81·8	43·3	40·0	69·9	70·9	39·2	28·2	11·0	81·9	Cal. Teeth worn. P 1 cm. long.
48·4	48·3	76·3	75·8	79·6	76·6	18·0	73·0	55·0	29·6	67·4	75·4	37·2	—	—	—	Cal. 3 carious teeth
49·1	50·4	83·6	78·0	87·2	87·1	32·4	83·7	49·1	43·6	59·4	80·4	40·2	30·5	9·7	90·1?	Cal. Teeth worn. P of Hyrtl.
44·2	43·8	82·9	81·3	94·4	84·0	35·5	82·3	60·5	49·0	61·8	77·1	41·1	30·4	10·7	87·8	Cal. Teeth worn. P
50·8	53·2	70·5	69·6	75·4	79·9	16·7	94·5	63·5	43·0	—	—	—	—	—	—	Cal. P.B. upwards
—	—	—	86·7	—	72·6	35·5	86·6	—	—	—	—	—	—	—	85·3	Cal. Teeth worn. P
—	—	88·5	—	92·2	—	—	81·0	—	35·9	—	—	—	—	—	—	Br. cal. – part f. S bridge and foran
—	—	81·1	—	83·2	—	—	86·3	64·4	54·4	—	—	—	—	—	91·5	Cal. – part f. P.B.
50·0	49·8	79·8	78·0	83·7	—	—	88·2	58·6	41·2	69·0	71·0	40·0	27·2	12·8	83·8?	Cal. Teeth much wo
41·4	42·5	77·6	75·8	83·4	—	—	87·5	52·3	26·0	61·0	73·2	45·7	35·8	10·0	83·2	Cal. P.B. flat with
45·0	46·5	—	75·1	—	85·6	25·4	81·6	46·2	44·4	61·6	75·0	43·4	31·6	11·8	86·8	Br. cal. – part f. Te coming on to fac
48·4	48·4	78·4	77·3	78·8	—	31·0	93·0	50·5	34·2	73·0	69·2	37·8	25·1	12·7	81·9	Cal. Teeth good. W frontal overlap 1 parietal. Spheno
48·0	47·2	79·3	79·6	83·2	77·3	38·0	99·7	70·3	67·8	62·9	72·1	45·0	29·7	15·3	87·4	Cal. br. old. Corona J equal. Sutura
48·8	48·2	—	78·3	—	—	—	89·6	58·3	81·2	59·8	78·2	42·0	31·7	10·3	88·5	Br. cal. – part f. A

DS/DC	SS/SC	Angles (in degrees) N ∠	A ∠	B ∠	θ_1	θ_2	P ∠	Remarks (see text, pp. 17—21)
55·5	36·4	69·6	69·0	41·4	22·9	18·5	87·5	Cal. br. Slight bathrocephaly. 2 diseased teeth. P.B. flat with sharp edge. SR. Flattening at obe pterygoid plate, anomalous process, 5 mm. long, probably supporting internal maxillary artery
72·7	58·8	65·5	76·3	38·2	28·7	9·5	85·8	Cal. P.B. upwards with sharp edge. S equal. JR. Wormian bones in lambdoid and squamous su
56·4	43·5	65·1	75·0	39·9	29·0	10·9	85·9?	Cal. br. P.B. downwards with sharp edge. SL. JR.
67·1	59·6	60·3	75·5	44·2	31·9	12·3	87·8	Cal. – part f. Teeth worn. P.B. upwards with sharp edge. SL. JR.
60·8	52·2	64·0	75·1	40·9	25·2	15·7	90·8	Cal. 1 carious tooth. P.B. upwards with rounded edge. SR. JR. Small process as in 1 on R. pter
46·4	35·7	64·5	70·2	45·3	32·7	12·6	82·8	Cal. Slight bathrocephaly. P.B. flat with sharp edge. SR. JR. Slight median torus occipitalis. T
64·1	51·5	68·6	69·1	41·3	25·6	16·7	85·8	Cal. Teeth worn. Slight bathrocephaly. P.B. upwards with L. edge blunt and R. double and groo
—	—	63·6	77·4	39·0	27·9	11·1	88·5	Cal. – part f. P.B. flat with blunt edge. SR. JR.
—	40·4	—	—	—	—	—	—	Cal. Edentulous. Alveolar margin absorbed. S equal. JR. P.B. upwards with blunt edge.
37·9	24·7	61·9	74·3	43·8	33·1	10·7	85·0	Cal. P.B. upwards with sharp edge. S equal. JL. Metopic suture. Slight RF + LP contact. Ling
—	—	62·2	67·4	50·4	32·8	17·6	85·0	Cal. Young adult. Teeth good. 2nd molar 4-cusped. 3rd molars coming down. P.B. upwards with 4 mm. Interparietal suture entirely closed.
58·4	42·6	—	—	—	—	—	—	Br. cal. – part f. JL. Median super-orbital torus. Process on pterygoid plate as in 1. 5 mm. Plag flattening. Flattening of obelion.
41·2	30·1	72·2	74·7	33·1	22·5	10·6	85·3	Cal. – part f. Slight bathrocephaly. P.B. upwards with sharp edge. SR. JL. Post-coronal cons
58·3	67·7	—	—	—	—	—	—	Cal. Edentulous. P.B. downwards with blunt edge. SR. JR.
53·5	47·7	58·8	78·9	42·3	32·7	9·6	88·5	Cal. Teeth worn. P.B. upwards with sharp edge. SL. JR. Metopic suture markedly dentate, in lin on R. malar very strong.
—	—	—	—	—	—	—	—	Cal. Edentulous. P.B. upwards with double edge. SR. J equal. Ossicle of lambda.
62·2	57·8	62·0	72·0	46·0	33·2	12·8	84·8	Cal. br. 2 carious teeth. P.B. upwards with sharp edge. J equal.
57·5	34·0	58·9	79·8	40·3	29·9	11·4	91·2	Cal. br. P.B. flat with blunt edge. JR.
59·5	52·0	60·1	72·3	47·6	35·0	12·6	84·9	Cal. R. 3rd molar diseased. P.B. upwards with double edge. S equal. JR.
47·8	34·0	67·8	67·9	44·3	27·2	17·1	85·0	Cal. Teeth much worn. P.B. upwards with rounded edge. SL. JR. Metopic suture. LF + RP 12
52·5	46·3	66·4	69·5	44·1	28·8	15·3	84·8	Cal. P.B. upwards with double edge. SR. JL.
47·6	34·0	66·3	69·9	43·8	26·7	17·1	87·0	Cal. P.B. upwards with rounded edge. S equal. JR.
65·0	55·0	59·3	71·9	48·8	30·5	18·3	90·2	Cal. – part f. P.B. flat with sharp edge. S equal. JL.
46·9	48·9	65·2	72·4	42·4	27·0	15·4	87·8	Cal. P.B. upwards with blunt edge. Small precondylar ridges. Slight torus palatinus. Marginal
51·1	41·3	65·9	74·5	39·6	26·8	12·8	87·3	Cal. P.B. flat with double edge. SR. JR. Inion strong. Precondylar process. Slight torus palat
61·3	51·6	—	—	—	—	—	—	Cal. br. Edentulous. P.B. upwards with sharp edge. J equal.
—	—	67·0	74·4	38·6	26·2	12·4	86·8	Cal. Teeth worn. P.B. flat with blunt edge. S equal. JR. Flattening of obelion.
—	—	66·7	74·3	39·0	29·4	9·6	83·9	Cal. – part f. P.B. flat with sharp edge. S equal. J equal. Slight post-coronal depression. Sligh
—	—	74·5	70·0	35·5	31·0	4·5	74·5	Br. cal. – part f. Teeth worn. 4-cusped 2nd molar. Pterygo-spinous bridge and foramen on R. s
69·0	53·1	—	—	—	—	—	—	Cal. old. Sagittal suture almost obliterated. Nearly edentulous. On R. side, 1st and 2nd molars rem tions in tympanic plate. P.B. upwards with blunt edge. S equal. JL.
50·2	37·6	62·6	70·4	47·0	31·9	15·1	85·5	Cal. Teeth good. P.B. upwards with sharp edge. S equal. JR.
59·4	52·0	61·0	72·0	47·0	30·0	17·0	89·0	Cal. – part f. Teeth good. Worn. P.B. flat with sharp edge. S equal. JL. Precondylar ridges.
43·3	40·0	69·9	70·9	39·2	28·2	11·0	81·9	Cal. Teeth worn. P.B. upwards with blunt edge. S equal. J equal. Metopic suture. RP + LF 5 1 cm. long.
55·0	29·6	67·4	75·4	37·2	—	—	—	Cal. 3 carious teeth. P.B. upwards with rounded edge. SL. JL. Low temporal squama.
49·1	43·6	59·4	80·4	40·2	30·5	9·7	90·1?	Cal. Teeth worn. P.B. flat with rounded edge. SR. JR. Slight post-coronal depression. On L. s of Hyrtl.
60·5	49·0	61·8	77·1	41·1	30·4	10·7	87·8	Cal. Teeth worn. Probably no 3rd molar on L. side. P.B. upwards with sharp edge. S equal. J
63·5	43·0	—	—	—	—	—	—	Cal. P.B. upwards with blunt edge, double on L. side. SR. JR.
—	—	—	—	—	—	—	85·3	Cal. Teeth worn. P.B. downwards with blunt edge. S equal. JR.
—	35·9	—	—	—	—	—	—	Br. cal. – part f. SR. JR. Slight bathrocephaly. Metopic suture. LF + RP 8 mm. Slight pos bridge and foramen.
64·4	54·4	—	—	—	—	—	91·5	Cal. – part f. P.B. upwards with sharp edge. SR. JR. Ossicle of pterion R. and L.
58·6	41·2	69·0	71·0	40·0	27·2	12·8	83·8?	Cal. Teeth much worn. L. 3rd molar carious. P.B. upwards with rounded edge. S equal. JL. Slight
52·3	26·0	61·0	73·2	45·7	35·8	10·0	83·2	Cal. P.B. flat with blunt edge. SR. JR. Trace of upper part of metopic suture.
46·2	44·4	61·6	75·0	43·4	31·6	11·8	86·8	Br. cal. – part f. Teeth good. 3rd molars probably suppressed. P.B. upwards with sharp edge. coming on to face. Sutura notha on L. side. Double on R. Small styliform process to R. squ
50·5	34·2	73·0	69·2	37·8	25·1	12·7	81·9	Cal. Teeth good. Worn. P.B. upwards with sharp edge. SL. JL. Median occipital torus. R. sutu frontal overlap 17 mm. On L. side, wormian bone (ossicle of asterion?) 50 × 50 mm. between parietal. Spheno-parietal sulcus and mastoidal groove well marked.
70·3	67·8	62·9	72·1	45·0	29·7	15·3	87·4	Cal. br. old. Coronal and sagittal sutures almost obliterated. Teeth good. Very much worn. P.B J equal. Sutura notha R. Inion strong.
58·3	81·2	59·8	78·2	42·0	31·7	10·3	88·5	Br. cal. – part f. Almost edentulous. P.B. upwards with sharp edge. L. malar marginal tubero

21)

Flattening at obelion. On R. side, on outer surface of
maxillary artery.
and squamous sutures.

as in 1 on R. pterygoid plate. 3 mm.
orus occipitalis. Temporal squama low.
. double and grooved. S equal. JR.

lunt edge.
LP contact. Linguiform process of occipital bone.
B. upwards with blunt edge. Metopic suture. LF + RP

n 1. 5 mm. Plagiocephaly. L. frontal and R. occipital

Post-coronal constriction.

dly dentate, in line with interparietal. Marginal process
oda.

ture. LF + RP 12 mm.

tinus. Marginal processes of malars strong.
Slight torus palatinus.

depression. Slight torus palatinus.
foramen on R. side.
d 2nd molars remain. 3rd molar coming down. Perfora-

condylar ridges.
ture. RP + LF 5 mm. Pars-occipital process on R. side,
squama.
pression. On L. side a porus crotaphitico-buccinatorius
edge. S equal. J equal.

mm. Slight post-coronal depression. Pterygo-spinous
nd L.
equal. JL. Slight torus palatinus. Slight bathrocephaly.
vith sharp edge. SL. JR. Pars facialis of lacrymal bone
process to R. squama. Inion strong.
tal torus. R. sutura notha. In temp. fossa large parieto-
50 mm. between parietal and mastoid replacing piece of
much worn. P.B. upwards with sharp edge. S equal.
r marginal tubercle well developed. Inion well marked.

		Lengths										
No.	Sex	*C*	*F*	*L′*	*L*	*B*	*B′*	*H*	*H′*	*OH*	*LB*	*Q*
47	♂	1524·0	185·5	186	186·5	144	87·5	128·5	128·5	107·5	100	306·5?
48	,,	1600·5	192·5	199	198	148	97	122·5	121·5	102	98	290
49	,,	1501·5?	180	185	183	139?	90·5	138	138	111·5	101	308
50	,,	—	—	—	—	—	101·5	—	—	118·5	—	—
51	♂?	—	181	—	189	—	95·5	—	—	—	—	—
52	♂	1554·5?	187	186·5	187·5	149	92·5	135	133·5	110·5	97·5	312
53	,,	1476·0	185	189	190	143	98·5	125	126	106	99·5	300
54	,,	—	—	—	—	—	92·5	—	—	—	—	—
55	,,	—	—	—	—	—	—	—	—	—	—	—
56	,,	—	—	—	—	—	92·5	—	—	—	—	—
57	,,	—	—	—	—	—	105·5	—	—	—	—	—
58	,,	1229·0	177·5	182	182	136·5	93·5	122	122·5	102·5	95·5	287
59	,,	—	179·5	182	180·5	154·5	99·5	134	132	115·3	95	328?
60	,,	—	185	—	188·5	139·5	99·5	—	126	—	100	—
61	,,	—	170	174	175	137	92·5	121·5	121·5	106·8	96	276
62	,,	—	192·5	—	192·5	—	105·5	—	131	—	106	—
63	,,	1425·0	186·5	184·5	186	137	95	132	132	108·5	93?	303
64	,,	1241·5	171·5	175	174·5	141·5	95	123·5	122·5	104·4	101·5	298
65	,,	—	—	—	—	—	90	—	—	—	—	—
66	,,	—	—	188·5??	—	138?	94	130·5	129·5?	107·2	104	298??
67	,,	1561·0?	187·5	190	190·5	146	94·5	128·5	127·5	114·4	102·5	324
68	,,	—	177·5?	—	178?	—	94·5	—	—	—	—	—
69	,,	1549·5	187	190·5	191	148·5	101·5	128·5	127·5	97·6	95·5	307·5
70	,,	1376·5?	189	189	190·5	131?	101	122·5	123·5	107	98·5	294
71	,,	1248·0	187	188	188·5	129	98	122·5	122·5	101·3	101·5	280
72	,,	—	189·5?	—	190?	—	96·5	—	—	—	—	—
73	,,	—	—	—	—	141·5	96	—	—	107·5	—	311
74	,,	1418·5?	178	181	181	140	92	130·5	130	107·5	100	299??
75	,,	—	185	189	186·5	146	97	—	—	112	—	318
76	,,	—	—	—	—	138	—	131·5	131·5	103·4	105·5	291
77	,,	1476·0	190	189	191	138·5	97	127·5	127·5	112·7	96	312
78	,,	—	181	—	182	147	95·5	—	129	—	99·5	—
79	,,	—	—	—	—	—	90	—	—	—	—	—
80	,,	—	—	—	—	—	—	—	—	—	—	—
81	,,	—	—	—	—	—	—	—	—	—	—	—
82	,,	—	—	—	—	—	—	—	—	—	—	—
83	♂?	1387·0	179·5	185	183	134	91·5	132	131	107	97·5	296
84	,,	1568·5	180·5	183	182	147	96	138·5	138·5	115·2	94·5	318
85	,,	1458·0	182·5	184	185·5	135	90·5	132·5	131·5	106·3	102	296·5
86	,,	—	—	—	—	—	98·5	—	—	—	—	—
87	,,	1283·5	178·5	183	182	130	89·5	123·5	123	99·5	96·5	280
88	,,	1403·5	181·5	183	183	135	101	128	127·5	111·5	97·5	305
89	,,	—	178·5	—	183	137·5	89	—	—	—	—	—
90	,,	—	—	—	—	149?	92	—	—	—	—	—
91	,,	1359·0	184·5	189	188	141·5	93	126	126	104·7	93	293
92	,,	1395·5?	171	175	176	138	85	125	123·5	104·3	89·5	295??
93	,,	1581·5?	192	197	196·5	137·5	101	134	133·5	111·5	107·5	303
94	,,	1565·0	189·5	191	190·5	146	98	134	133·5	111·5	102·5	310
95	,,	1212·5?	178	184	185·5	133·5	94	116·5	118·5	93·5	100	268
96	,,	—	—	—	—	—	95	—	—	—	—	—
97	,,	—	—	—	—	—	93·5	—	—	—	—	—
98	,,	—	—	—	—	—	—	—	—	—	—	—
99	,,	—	—	—	—	—	—	—	—	—	—	—

		Arcs										Face				
OH	*LB*	*Q*	*Q′*	*S*	S_1	S_2	S_3	S_1'	S_2'	S_3'	*U*	*PH*	*G′H*	*GB*	*J*	*NH*
107·5	100	306·5?	308?	369	132	123	114	115	111	93	520?	—	75·5?	95·1	—	54·0
102	98	290	291	389	124	133	132	110·5	117	106·5	550	19·6	70·8	92·6	124·5?	52·0
111·5	101	308	311	370	132	127	111	116·5	113	90	514	16·8?	66·9?	83·8	131	52·0
118·5	—	—	—	—	131	—	—	113·5	—	—	—	21·2?	74·3	104·8	136·5	—
—	—	—	—	—	129	115	—	113·5	104	—	—	—	—	90·0	—	50·8
110·5	97·5	312	318	386·5?	135	118·5?	113?	117·5	108·5?	101·5?	535?	—	69·3	95·0	134	—
106	99·5	300	299	377	128	120	129	112·5	107·5	102·5	533	22·8	77·1	96·1	133·5	53·8
—	—	—	—	—	132	124?	—	117	110?	—	—	27·0	75·0	—	—	50·2
—	—	—	—	—	129	—	—	112·5	—	—	—	20·2	63·9	—	—	—
—	—	—	—	—	127	—	—	109·5	—	—	—	24·0?	74·1	—	—	51·1
—	—	—	—	—	132	—	—	114	109	—	—	18·8?	69·2	99·8?	—	—
102·5	95·5	287	288	359	124	116	119	108·5	106	92	501	18·8	65·3	89·7	125·5	46·4
115·3	95	328?	380?	372?	131	127?	114?	116·5	117·5?	92?	541?	19·9	75·5	93·8	137?	55·1
—	100	—	—	371	127	124	120	113	110	98·5	531?	21·0	76·3	—	—	54·1
106·8	96	276	280	349	125	109	115	109·5	97·5	90·5	494	19·8?	70·0?	—	—	49·1
—	106	—	—	377	127	138	112	108	124	—	—	18·0	70·2	91·2	—	50·1
108·5	93?	303	306	389	136	144	109	115?	125	90	520	—	—	—	—	—
104·4	101·5	298	299	340·5	113	121·5	106	101	109	87	501	—	67·8	100·0	135	52·1
—	—	—	—	—	119	—	—	105·5	—	—	—	18·0?	68·9	87·5	131·5	50·1
107·2	104	298??	300??	366	118	131	117	106	117	98	—	19·0	69·0	86·5	127	50·1
114·4	102·5	324	323	379	130	125	124	114	114·5	102	535	23·4	73·0	88·0	—	47·1
—	—	—	—	—	124	132	—	108	115·5	—	—	14·9	66·1	95·6	—	49·1
97·6	95·5	307·5	309	389	135	120	134	118·5	110	102·5	540	20·0	74·9	93·3	131	54·1
107	98·5	294	297·5	370	128	126	116	113·5	112·5	95	521	18·9	67·0	86·0	127	48·1
101·3	101·5	280	283	366	126·5	121	118·5	107·5	109	98·5	523	16·6	67·3	—	—	49·1
—	—	—	—	—	136	129	—	118	116	—	—	24·1	73·1	97·1	—	46·1
107·5	—	311	311	—	121	—	—	108·5	—	—	—	20·0	70·0	96·9	124·5?	46·1
107·5	100	299??	300??	368	134	116	118	116	103·5	94	507?	20·0?	72·5?	100·0	132·5	52·1
112	—	318	323	380	136·5	127	116·5	119·5	112	94	529	17·0	67·4	87·1	—	50·1
103·4	105·5	291	295	—	—	124	107	111	111·5	91·5	—	—	—	—	—	—
112·7	96	312	316	393	133	141	119	115·5	122·5	90·5	526	18·8	65·2	91·0	—	45·1
—	99·5	—	—	372	123	124	125	109	111	99·5	522	—	72·8	86·8	—	—
—	—	—	—	—	—	—	—	—	—	—	—	17·2	62·0	84·0	—	44·1
—	—	—	—	—	—	—	—	—	—	—	—	25·8	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	21·5?	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	16·4	—	91·0	—	—
107	97·5	296	298	360	122	118	120	109	109	101	508	16·6?	68·8	82·0	118·5	52·1
115·2	94·5	318	323	382	138	128	116	121·5	115	95	523	—	—	80·2	128·5	49·1
106·3	102	296·5	297	371	122	136	113	108	118	95·5	510	20·0	66·8	85·3	126	45·1
—	—	—	—	—	137	—	—	121·5	—	—	—	22·0	65·2	80·1	—	43·1
99·5	96·5	280	281	357	124	117	116	109·5	105	94	508	21·3	71·9	82·0	123·5	51·1
111·5	97·5	305	307	367	129	125	113	111	113	92	514	14·9	64·4	95·9?	—	49·1
—	—	—	—	—	123	126	—	110	110	—	505	17·5?	64·9?	90·0	122·5	47·1
—	—	—	—	—	136	—	—	118	—	—	—	16·5	70·5	87·1	—	53·1
104·7	93	293	293	387	132	135	120	114	118	98	524	17·0	67·5	—	—	49·1
104·3	89·5	295??	295??	357	122	120	115	107	107	94·5	—	20·0?	68·5?	84·8	—	49·1
111·5	107·5	303	303	385	132	114	139	119	104·5	110·5	540	19·8?	70·8	88·9	—	50·1
111·5	102·5	310	313	382	127	130	125	112·5	117·5	100	536	18·1	72·0	96·9	—	53·1
93·5	100	268	270	350	118	118	114	106·5	106	97	506	21·0	70·0	—	—	48·1
—	—	—	—	—	134	129	—	116	115	—	—	16·7	63·0	—	—	45·1
—	—	—	—	—	118?	—	—	—	—	—	—	18·8?	85·2?	87·8	—	47·1
—	—	—	—	—	—	—	—	—	—	—	—	17·5	71·0	—	—	54·1
—	—	—	—	—	—	—	—	—	—	—	—	15·6	—	—	—	51·1

TABLE OF ABSOLUTE AND INDICIAL MEASUR

		Nose									Orbits						Palate and Prof			
B	*J*	*NH'*	*NH R*	*NH L*	*NB*	*DS*	*DC*	*DA*	*SS*	*SC*	O_1R	O_1L	O_2R	O_2L	O_1'	*EOW*	G_1	G_1'	G_2	*GL*
5·1	—	54·0	55·1	56·1	22·7	16·0	19·6	36·2	5·5	8·0	39·3	39·8	36·5	37·3	37·3	92·5	52·8	47·1	39·7	95·0?
2·6	124·5?	52·0	51·4	53·2	27·2	13·9	21·1	36·0	6·9	13·1	40·1	41·8	34·0	34·0	38·0	96·7	—	—	40·2?	97·1
3·8	131	52·0	51·6	51·2	21·9	15·4?	19·5?	36·0?	3·0	6·9	40·8	39·9	31·3	30·6	37·6	92·5	49·8	45·7	39·0?	90·7?
4·8	136·5	—	53·0	53·0	27·2	13·9	24·8	41·5	5·0	7·6	41·8	42·0	31·4	32·0	39·8	102·1	—	—	48·0	—
0·0	—	50·8?	52·1	52·0	25·0	15·9	21·6	38·4	4·6	8·0	43·2	43·3	31·5	33·5	41·1	100·1	—	—	—	—
5·0	134	—	51·2	51·5	27·0	13·1	23·0	39·1	—	—	42·8	41·3	34·3	35·7	38·6	94·2	51·3	46·1	39·0	88·5
6·1	133·5	53·8	53·8	55·0	24·1	14·9	18·1	31·6	5·7	8·8	41·4	41·2	36·2	35·6	39·0	95·0	49·4	46·8	—	89·0
—	—	50·2?	—	51·4	—	11·9	22·5	32·2	3·5	8·8	—	42·0	—	37·5	—	98·1?	—	—	—	—
—	—	—	—	46·5	—	—	—	—	—	—	—	40·7	—	30·0	—	—	—	—	—	—
—	—	51·5?	50·5	52·1	25·2	14·5	23·0	37·0	5·5	9·8	—	42·5	35·2	36·1	—	99·0?	—	—	—	—
9·8?	—	—	50·7	50·5	24·5	13·8	28·4	42·0	4·4	9·9	43·9	43·7	34·0	35·0	40·0	105·0	47·7	44·3	37·8	—
9·7	125·5	46·8	47·1	47·4	26·8	10·0	21·8	31·0	5·2	12·2	42·1	42·6	34·4	33·9	41·2	99·2	49·9	47·6	40·9	92·2
3·8	137?	55·5	55·8	55·0	22·1	11·5	22·0	33·0	3·8	8·1	43·0	42·8	35·3	35·5	40·0	99·3	47·4	44·1	37·1	91·8
—	—	54·9	—	56·0	—	14·2	22·5?	35·2?	6·1	10·0	—	43·5	—	38·5	—	—	—	—	—	94·0
—	—	49·0	—	48·8	—	—	—	—	—	—	—	42·0	—	35·8	—	—	—	—	—	89·0?
1·2	—	50·3	51·8	50·7	23·2	12·2	24·1	37·3	5·9	11·2	41·0	40·2	27·5	28·5	35·0	96·7	48·8	44·3	40·2	98·5
—	—	—	—	—	—	—	—	—	—	—	—	40·4	—	35·3	—	92·4?	—	—	—	—
0·0	135	52·8??	50·8	51·0	25·6	14·0	23·9	41·2	5·2	11·3	42·9	43·5	35·1	35·4	39·5	100·2	51·4	46·9	41·7	99·8
7·5	131·5	50·1?	50·9	49·8	21·2	13·5	20·0	34·0	5·1	9·0	40·1	42·3	33·8	33·5	37·5	94·6	—	—	43·0	—
6·5	127	50·0	50·2	49·8	22·5	9·9	23·0	35·8	5·0	13·3	41·2	41·2	31·5	32·0	40·0	96·9	52·0	48·0	37·9	93·5
8·0	—	47·6	50·2	50·2	22·0	14·8	25·3	42·2	5·0	10·0	41·3	42·5	33·8	32·5	37·1	—	52·8	47·5	—	101·0
5·6	—	49·5	48·6	49·0	22·2	11·0?	—	—	4·3	5·5	43·0	45·4	—	31·8	—	101·0	—	38·2	40·8?	—
3·3	131	54·0	52·0	52·0	22·8	11·2	19·0?	33·0?	4·1	8·0	43·0	42·8	39·1	39·0	40·0	97·6	51·1	48·5	42·2?	91·4
6·0	127	48·5	51·4	51·0	25·0	13·8	25·0	40·4	5·2	11·1	42·0	42·5	34·5	33·5	38·9	98·9	50·0	45·8	40·1	94·9
—	—	49·6	51·1	50·8	25·6	13·6	23·0	37·1	4·5	9·3	—	43·1	31·7	33·0	—	—	50·0	47·5	37·7	97·0
7·1	—	46·0	52·8	53·2	27·0	13·7	21·9	37·2?	4·5	8·2	42·4	44·0	33·5	33·5	39·2	96·9	—	—	—	—
6·9	124·5?	46·5	47·2	48·5	21·7	12·7?	20·6?	36·1?	6·9	9·2	42·0	40·5	31·7	31·1	39·1	95·1	49·2	46·5	36·8	—
0·0	132·5	52·2	50·1	50·4	24·2	10·3	20·2	32·2	2·5	5·0	43·6	44·9	32·6	32·6	40·3	98·2	51·7	48·1	41·7	98·1
7·1	—	50·0	50·3	50·1	23·1	14·6	20·2	36·1	5·6	11·4	41·8	41·8	32·5	32·8	39·5	96·0	46·0	42·5	—	—
—	—	—	—	—	—	—	—	—	—	—	—	42·3	—	33·8	—	—	—	—	—	—
1·0	—	45·4	49·0	48·7	27·0	13·6	22·4	37·4	4·3	8·1	43·5	43·2	34·0	34·9	40·8	100·0	48·7	46·0	36·7	93·3
8·8	—	—	52·0	53·6	25·5	13·6	21·8	35·0	5·5	11·1	41·8	43·2	34·7	35·8	40·0	99·9	48·0	43·9	38·0	89·8
4·0	—	44·0	45·2	44·1	24·9	—	23·8	—	—	—	40·2	40·0	33·0	34·8	37·9	94·6	46·2	43·0	—	—
—	—	—	—	—	26·5	10·1	22·5	31·0	4·0	—	—	—	—	—	—	—	47·5	44·8	41·3?	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	46·1	44·0	36·5	—
1·0	—	—	—	—	24·9	—	—	—	—	—	—	—	—	—	—	—	45·1	42·5	42·2	—
2·0	118·5	52·0	51·6	50·0	23·5	11·1	20·0	32·2	5·1	7·2	43·5	42·8	37·0	37·0	40·3	95·0	46·5	43·6	39·2?	87·1
0·2	128·5	49·7	50·3	50·3	21·9	11·2	19·1	33·6	4·5	5·1	42·3	43·5	36·9	37·5	39·0	94·8	—	—	—	—
5·3	126	45·3	48·0	—	—	11·7	18·5?	42·0	4·6	6·0	45·1	46·0	36·0	34·9	42·8	97·1	—	—	—	89·0
0·1	—	43·6	45·1	46·2	24·1	14·0	22·0?	37·3	5·5	10·2	40·0	42·1	33·9	35·0	38·0	96·0	47·2	44·8	—	—
2·0	123·5	51·8	51·8	50·2	23·5	12·0	19·5	31·6	5·6	8·2	40·0	41·2	36·3	36·1	38·8	93·1	43·2	41·6	32·4	90·0
5·9?	—	49·3	49·4	48·8	25·0	11·5	22·2	37·3	5·2	10·0	41·8	41·5	31·8	33·2	39·5	99·1	50·8	47·8	40·0?	93·8
0·0	122·5	47·9	50·4	51·0	26·0	14·9	22·5	39·5	5·6	10·0	40·2	41·0	31·5	31·8	40·0	96·3	—	—	—	—
7·1	—	53·3	52·0	53·8	25·4?	14·2	20·5	39·2	5·0	8·0	42·0	44·9	35·0	34·5	40·0	98·1	—	—	—	—
—	—	49·2	51·7	51·0	21·0	13·5?	17·5	33·9	3·0??	5·8??	41·0	—	34·8	34·8	38·5	92·4??	45·2	42·5	—	85·5
4·8	—	49·0	49·4	48·0	19·6	10·1	18·5?	29·3	3·8	6·0	40·4	41·5	34·2	33·8	39·2?	91·0	45·3	42·8	34·1?	80·2
8·9	—	50·5	50·1	51·0	28·7	12·6?	23·5?	33·0?	6·1	13·5	41·0	41·2	33·0	33·5	39·0	96·1	47·0	43·0	38·8	97·0
6·9	—	53·1?	52·0	52·5	23·1	11·5	23·1	28·8	4·7	8·1	41·0	41·0	33·1	33·2	39·9	99·1	48·7	45·8	40·5	97·5
—	—	48·9?	50·9	—	—	—	—	—	5·0	8·6	42·5	—	36·8	—	41·0	99·0??	—	—	—	92·0
—	—	45·8	—	47·6	—	—	—	—	3·0	9·5?	—	42·5	—	34·9	—	—	—	—	—	—
7·8	—	47·5	50·3	50·5	23·4	8·3??	20·2	34·0	2·7	5·8	41·0	42·2	34·5	35·0	39·0	95·1	48·0	44·9	40·3	—
—	—	54·4?	52·5?	53·2?	22·8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	51·4?	51·0?	51·6?	25·2	—	—	—	—	—	42·0	—	—	—	—	—	—	36·2	35·2	—

TABLE OF ABSOLUTE AND INDICIAL MEASUREMENTS OF THE INDIVI

				Orbits						Palate and Profile						Foramen				
DC	*DA*	*SS*	*SC*	O_1R	O_1L	O_2R	O_2L	O_1'	*EOW*	G_1	G_1'	G_2	*GL*	*EB*	*EH*	*fml*	*fmb*	*Oc.I.*	*B/L'*	*H/*
19·6	36·2	5·5	8·0	39·3	39·8	36·5	37·3	37·3	92·5	52·8	47·1	39·7	95·0?	40·0	13·6	36·7	32·0	58·3	77·4	69·
21·1	36·0	6·9	13·1	40·1	41·8	34·0	34·0	38·0	96·7	—	—	40·2?	97·1	40·5?	—	39·1	30·0	57·6	77·4	61·
19·5?	36·0?	3·0	6·9	40·8	39·9	31·3	30·6	37·6	92·5	49·8	45·7	39·0?	90·7?	39·0?	11·0?	35·4	31·0	57·9	75·2	74·
24·8	41·5	5·0	7·6	41·8	42·0	31·4	32·0	39·8	102·1	—	—	48·0	—	47·9	12·1	—	—	—	—	—
21·6	38·4	4·6	8·0	43·2	43·3	31·5	33·5	41·1	100·1	—	—	—	—	—	—	—	—	—	—	—
23·0	39·1	—	—	42·8	41·3	34·3	35·7	38·6	94·2	51·3	46·1	39·0	88·5	39·2	9·0	31·8	28·9	71·3	79·9	72·
18·1	31·6	5·7	8·8	41·4	41·2	36·2	35·6	39·0	95·0	49·4	46·8	—	89·0	—	—	35·0	32·0	56·7	75·7	66·
22·5	32·2	3·5	8·8	—	42·0	—	37·5	—	98·1?	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	40·7	—	30·0	—	—	—	—	—	—	—	—	—	—	—	—	—
23·0	37·0	5·5	9·8	—	42·5	35·2	36·1	—	99·0?	—	—	—	—	—	—	—	—	—	—	—
28·4	42·0	4·4	9·9	43·9	43·7	34·0	35·0	40·0	105·0	47·7	44·3	37·8	—	37·5	12·3	—	—	—	—	—
21·8	31·0	5·2	12·2	42·1	42·6	34·4	33·9	41·2	99·2	49·9	47·6	40·9	92·2	40·6	10·4	34·2	29·9	55·4	75·0	67·
22·0	33·0	3·8	8·1	43·0	42·8	35·3	35·5	40·0	99·3	47·4	44·1	37·1	91·8	37·0	11·2	36·7	32·6	57·6	84·9	73·
22·5?	35·2?	6·1	10·0	—	43·5	—	38·5	—	—	—	—	—	94·0	—	—	35·9	30·6	58·8	—	—
—	—	—	—	—	42·0	—	35·8	—	—	—	—	—	89·0?	—	—	33·1	30·0	56·2	78·7	69·
24·1	37·3	5·9	11·2	41·0	40·2	27·5	28·5	35·0	96·7	48·8	44·3	40·2	98·5	40·0	16·2	34·9	—	—	—	—
—	—	—	—	—	40·4	—	35·3	—	92·4?	—	—	—	—	—	—	36·0	30·0	59·2	74·3	71·
23·9	41·2	5·2	11·3	42·9	43·5	35·1	35·4	39·5	100·2	51·4	46·9	41·7	99·8	41·5	6·5	36·0	27·5	58·8	80·9	70·
20·0	34·0	5·1	9·0	40·1	42·3	33·8	33·5	37·5	94·6	—	—	43·0	—	43·0	—	—	—	—	—	—
23·0	35·8	5·0	13·3	41·2	41·2	31·5	32·0	40·0	96·9	52·0	48·0	37·9	93·5	37·5	10·0	36·2	29·5	60·5	73·2	69·
25·3	42·2	5·0	10·0	41·3	42·5	33·8	32·5	37·1	—	52·8	47·5	—	101·0	—	—	36·9	28·1	58·9	76·8	67·
—	—	4·3	5·5	43·0	45·4	—	31·8	—	101·0	—	38·2	40·8?	—	40·5?	7·0	—	—	—	—	—
19·0?	33·0?	4·1	8·0	43·0	42·8	39·1	39·0	40·0	97·6	51·1	48·5	42·2?	91·4	42·4?	14·8	37·5	32·6	55·0	78·0	67·
25·0	40·4	5·2	11·1	42·0	42·5	34·5	33·5	38·9	98·9	50·0	45·8	40·1	94·9	40·0	11·0	37·5	30·2	58·6	69·3	64·
23·0	37·1	4·5	9·3	—	43·1	31·7	33·0	—	—	50·0	47·5	37·7	97·0	38·0	6·0	40·8	32·6	59·8	68·7	65·
21·9	37·2?	4·5	8·2	42·4	44·0	33·5	33·5	39·2	96·9	—	—	—	—	—	—	—	—	—	—	—
20·6?	36·1?	6·9	9·2	42·0	40·5	31·7	31·1	39·1	95·1	49·2	46·5	36·8	—	36·5	13·5	—	—	—	—	—
20·2	32·2	2·5	5·0	43·6	44·9	32·6	32·6	40·3	98·2	51·7	48·1	41·7	98·1	42·0	12·1	33·7	29·5	56·8	77·3	72·
20·2	36·1	5·6	11·4	41·8	41·8	32·5	32·8	39·5	96·0	46·0	42·5	—	—	—	—	—	—	57·6	77·2	—
—	—	—	—	—	42·3	—	33·8	—	—	—	—	—	—	—	—	35·0	29·8	62·1	—	—
22·4	37·4	4·3	8·1	43·5	43·2	34·0	34·9	40·8	100·0	48·7	46·0	36·7	93·3	36·6	8·0	36·6	30·8	54·8	73·3	67·
21·8	35·0	5·5	11·1	41·8	43·2	34·7	35·8	40·0	99·9	48·0	43·9	38·0	89·8	37·5	11·5	33·1	27·8	56·8	—	—
23·8	—	—	—	40·2	40·0	33·0	34·8	37·9	94·6	46·2	43·0	—	—	—	—	—	—	—	—	—
22·5	31·0	4·0	—	—	—	—	—	—	—	47·5	44·8	41·3?	—	41·0?	13·9	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	46·1	44·0	36·5	—	36·9	7·2	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	45·1	42·5	42·2	—	42·0	10·2	—	—	—	—	—
20·0	32·2	5·1	7·2	43·5	42·8	37·0	37·0	40·3	95·0	46·5	43·6	39·2?	87·1	39·4?	5·6??	40·5	30·0	61·0	72·4	71·
19·1	33·6	4·5	5·1	42·3	43·5	36·9	37·5	39·0	94·8	—	—	—	—	—	—	40·1	30·0	58·6	80·3	75·
18·5?	42·0	4·6	6·0	45·1	46·0	36·0	34·9	42·8	97·1	—	—	—	89·0	—	8·1??	36·4	30·2	61·4	73·4	72·
22·0?	37·3	5·5	10·2	40·0	42·1	33·9	35·0	38·0	96·0	47·2	44·8	—	—	—	—	—	—	—	—	—
19·5	31·6	5·6	8·2	40·0	41·2	36·3	36·1	38·8	93·1	43·2	41·6	32·4	90·0	32·5	11·9	40·0	34·4	57·8	71·0	67·
22·2	37·3	5·2	10·0	41·8	41·5	31·8	33·2	39·5	99·1	50·8	47·8	40·0?	93·8	40·0?	11·4	37·0	28·3	58·2	73·8	69·
22·5	39·5	5·6	10·0	40·2	41·0	31·5	31·8	40·0	96·3	—	—	—	—	—	10·2	—	—	—	—	—
20·5	39·2	5·0	8·0	42·0	44·9	35·0	34·5	40·0	98·1	—	—	—	—	—	—	—	—	—	—	—
17·5	33·9	3·0??	5·8??	41·0	—	34·8	34·8	38·5	92·4??	—	—	—	—	—	—	—	—	—	—	—
18·5?	29·3	3·8	6·0	40·4	41·5	34·2	33·8	39·2?	91·0	45·2	42·5	—	85·5	—	—	33·8	28·2	58·4	74·9	66·
23·5?	33·0?	6·1	13·5	41·0	41·2	33·0	33·5	39·0	96·1	45·3	42·8	34·1?	80·2?	34·0?	—	36·0	31·9	58·8	78·9	71·
23·1	28·8	4·7	8·1	41·0	41·0	33·1	33·2	39·9	99·1	47·0	43·0	38·8	97·0	38·5	10·2?	37·3	33·0	56·7	69·8	68·
—	—	5·0	8·6	42·5	—	36·8	—	41·0	99·0??	48·7	45·8	40·5	97·5	40·5	11·0	37·0	27·9	57·1	76·4	70·
—	—	3·0	9·5?	—	42·5	—	34·9	—	—	—	—	—	92·0	—	—	37·1?	—	62·1	72·6	63·
20·2	34·0	2·7	5·8	41·0	42·2	34·5	35·0	39·0	95·1	48·0	44·9	40·3	—	40·0	11·2	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	42·0	—	—	—	—	—	—	36·2	35·2	—	35·6	9·1	—	—	—	—	—

E INDIVIDUAL CRANIA. (LENGTHS IN MILLIMETRES.)

Indices

Oc.I.	B/L′	H/L′	B/L	H/L	B/H	H′/L	B/H′	$\frac{B-H'}{L}$	G′H/GB	$\frac{NB/NH}{R}$	$\frac{NB/NH}{L}$	$\frac{O_2/O_1}{R}$	$\frac{O_2/O_1}{L}$	O_2/O_1'	G_2/G_1	EH/EB	fmb/fml
58·3	77·4	69·1	77·2	68·9	112·1	68·9	112·1	8·3	79·4	41·2	40·5	92·9	93·7	97·9	75·2	34·0	87·2
57·6	77·4	61·6	74·7	61·9	120·8	61·4	121·8	13·3	76·5	52·9	51·1	84·8	81·3	89·5	—	—	76·7
57·9	75·2	74·6	76·0	75·4	100·7	75·4	100·7	0·6	79·8	42·4	42·8	76·7	76·7	83·2	—	28·2	87·6
—	—	—	—	—	—	—	—	—	70·9	51·3	51·3	75·1	76·2	78·9	—	25·7	—
71·3	79·9	72·4	79·5	72·0	110·4	71·2	111·6	8·3	—	48·0	48·1	72·9	77·4	76·6	—	—	—
56·7	75·7	66·1	75·3	65·8	114·4	66·3	113·5	9·0	72·9	52·7	52·4	80·1	86·4	88·9	76·0	23·0	90·9
—	—	—	—	—	—	—	—	—	80·2	44·8	43·8	87·4	86·4	92·8	—	—	91·4
—	—	—	—	—	—	—	—	—	—	—	—	—	89·3	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	73·7	—	—	—	—
65·4	75·0	67·0	75·0	67·0	111·9	67·3	111·4	7·7	69·3	49·9	48·4	—	84·9	—	—	—	—
57·6	84·9	73·6	85·6	74·2	115·3	73·1	117·0	12·5	72·8	48·3	48·5	77·4	80·1	85·0	79·2	32·8	—
58·8	—	—	74·0	—	—	66·8	110·7	7·2	80·5	56·9	56·5	81·7	79·6	83·5	82·0	25·6	87·4
56·2	78·7	69·8	78·3	69·4	112·8	69·4	112·8	8·9	—	39·6	40·2	82·1	82·9	88·2	78·3	30·3	88·8
—	—	—	—	—	—	68·1	—	—	—	—	—	—	88·5	—	—	—	85·2
59·2	74·3	71·5	73·7	71·0	103·8	71·0	103·8	2·7	—	—	—	—	85·2	—	—	—	90·6
58·8	80·9	70·0	81·1	70·8	114·6	70·2	115·5	10·9	77·0	44·8	45·8	67·1	70·9	78·6	82·4	39·5	—
—	—	—	—	—	—	—	—	—	—	—	—	—	87·4	—	—	—	83·3
60·5	73·2	69·2	—	—	105·7	—	106·6	—	67·8	50·4	50·2	81·8	81·4	88·9	81·1	15·7	76·4
58·9	76·8	67·6	76·6	67·5	113·6	66·9	114·5	9·7	78·7	41·7	42·6	84·3	79·2	90·1	—	—	—
—	—	—	—	—	—	—	—	—	79·8	44·8	45·2	76·4	77·7	78·8	71·2	26·7	81·5
65·0	78·0	67·5	77·7	67·3	115·6	66·8	116·5	10·9	83·0	43·8	43·8	81·8	76·5	91·1	—	—	76·2
58·6	69·3	64·8	68·8	64·3	106·9	64·8	106·1	4·0	69·1	45·7	45·3	—	70·0	—	—	17·3	—
59·8	68·7	65·2	68·4	65·0	105·3	65·0	105·3	3·4	80·3	43·8	43·8	90·9	91·1	97·7	82·6	34·9	86·9
—	—	—	—	—	—	—	—	—	77·9	48·6	49·0	82·1	78·8	88·7	80·2	26·8	80·5
—	—	—	—	—	—	—	—	—	—	50·1	50·4	—	76·7	—	75·4	15·8	79·9
56·8	77·3	72·1	77·3	72·1	107·3	71·8	107·7	5·5	75·3	51·1	50·8	79·0	76·1	85·5	—	—	—
57·6	77·2	—	78·3	—	—	—	—	—	72·2	46·0	44·7	75·5	76·8	81·1	74·8	37·0	—
62·1	—	—	—	—	104·9	—	104·9	—	72·5	48·3	48·0	74·8	72·6	80·9	80·7	28·8	87·5
64·8	73·3	67·5	72·5	66·8	108·6	66·8	108·6	5·7	77·4	45·9	46·1	77·8	78·5	82·3	—	—	—
56·8	—	—	80·8	—	—	70·9	114·0	—	—	—	—	—	79·9	—	—	—	85·1
—	—	—	—	—	—	—	—	—	71·6	55·1	55·4	78·2	80·8	83·3	75·4	22·2	84·2
—	—	—	—	—	—	—	—	—	83·9	49·0	47·6	83·0	82·9	86·8	79·2	30·7	84·0
—	—	—	—	—	—	—	—	—	73·8	55·1	56·5	82·1	87·0	87·1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	86·9	33·9	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	79·2	19·5	—
70·0	72·4	71·4	73·2	72·1	101·5	71·6	102·3	1·6	83·9	45·5	47·0	85·1	86·4	91·8	93·6	24·3	—
66·6	80·3	75·7	80·8	76·1	106·1	76·1	106·1	4·7	—	43·5	43·5	87·2	86·2	94·6	84·3	14·2	74·1	—
67·4	73·4	72·0	72·8	71·4	101·9	70·9	102·7	2·1	78·3	—	—	79·8	75·9	84·1	—	—	74·8
—	—	—	—	—	—	—	—	—	81·4	53·4	52·2	84·8	83·1	89·2	—	—	83·0
68·8	71·0	67·5	71·4	67·9	105·3	67·6	105·7	3·8	87·7	45·4	46·8	90·7	87·6	93·6	75·0	36·0	—
72·2	73·8	69·9	73·8	69·9	105·5	69·7	105·9	4·1	67·2	50·6	51·2	76·1	80·0	80·5	78·7	28·5	86·0
—	—	—	75·1	—	—	—	—	—	—	—	—	—	—	—	—	—	76·5
—	—	—	—	—	—	—	—	—	72·1	51·6	51·0	78·4	77·6	78·8	—	23·4	—
74·4	74·9	66·7	75·3	67·0	112·3	67·0	112·3	8·3	80·9	48·8	47·2	83·3	76·8	87·5	—	—	—
68·8	78·9	71·4	78·4	71·0	110·4	70·2	111·7	8·2	—	40·6	41·2	84·9	—	90·4	—	—	83·4
67·1	69·8	68·0	70·0	68·2	102·6	67·9	103·0	2·1	80·8	39·7	40·8	84·7	81·4	87·2	75·3	—	88·6
71·1	76·4	70·2	76·6	70·3	109·0	70·1	109·4	6·5	79·6	57·3	56·3	80·5	81·3	84·6	82·6	26·5?	88·5
71·1	72·6	63·3	72·0	62·8	114·6	63·9	112·7	8·1	74·3	44·4	44·0	80·7	81·0	83·0	83·2	27·2	75·4
—	—	—	—	—	—	—	—	—	—	—	—	86·6	—	89·8	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	82·1	—	—	—	—
—	—	—	—	—	—	—	—	—	97·0	46·5	46·3	84·1	82·9	88·5	84·0	28·0	—
—	—	—	—	—	—	—	—	—	—	43·4	42·9	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	49·4	48·8	—	—	—	—	25·6	—

Angles (in degrees)

O_2/O_1 L	O_2/O_1'	G_2/G_1	EH/EB	fmb/fml	DS/DC	SS/SC	$N\angle$	$A\angle$	$B\angle$	θ_1	θ_2	$P\angle$	
93·7	97·9	75·2	34·0	87·2	81·6	68·8	63·7	71·3	45·0	31·2	13·8	85·1	Cal. R. canine delayed. 3rd molars ha
81·3	89·5	—	—	76·7	65·9	52·7	67·9	69·8	42·3	31·9	10·4	80·2	Cal. Teeth good. Worn. 4-cusped 2nd
													JL. Sutura notha. Hook of lacrym
76·7	83·2	—	28·2	87·6	79·0	43·5	61·2	78·7	40·1	31·4	8·7	87·4	Cal. Small teeth. P.B. flat with sharp
76·2	78·9	—	25·7	—	56·0	65·8	—	—	—	—	—	83·0	Cal. br. Teeth good. Worn. P.B. flat
													middle third.
77·4	76·6	—	—	—	73·6	57·5	—	—	—	—	—	—	Cal. br. P.B. upwards with sharp edge
86·4	88·9	76·0	23·0	90·9	57·0	—	61·3	75·2	43·5	28·7	14·8	90·0	Cal. br. Teeth good. P.B. rounded. S
86·4	92·8	—	—	91·4	82·3	64·8	58·7	73·3	48·0	20·5	17·5	90·8	Cal. Teeth worn. P.B. upwards with s
89·3	—	—	—	—	52·9	39·8	—	—	—	—	—	—	Br. cal. – part f. P.B. flat with round
73·7	—	—	—	—	—	—	—	—	—	—	—	—	Left half of cal. P.B. upwards with ro
													frontal overlap. L. malar marginal
84·9	—	—	—	—	63·0	56·1	—	—	—	—	—	—	Part dome + f. P.B. flat with rounde
80·1	85·0	79·2	32·8	—	48·6	44·4	—	—	—	—	—	—	Br. cal. – part f. P.B. flat with round
79·6	83·5	82·0	25·6	87·4	45·9	42·6	66·5	69·8	42·3	29·5	14·2	84·0	Cal. Teeth good. Worn. P.B. rounded
82·9	88·2	78·3	30·3	88·8	52·3	46·9	63·7	69·0	47·3	30·2	17·1	86·1	Cal. br. 4-cusped 2nd molar L. P.B.
88·5	—	—	—	85·2	63·1	61·0	62·5	71·5	46·0	—	—	—	Br. cal. – part f. P.B. flat with sharp
85·2	—	—	—	90·6	—	—	62·3	73·7	44·0	34·0	10·0	83·7?	Br. cal. – part f. P.B. upwards with
70·9	78·6	82·4	39·5	—	50·6	52·7	64·0	76·1	39·9	—	—	—	Cal. br. Teeth good. P.B. upwards wi
87·4	—	—	—	83·3	—	—	—	—	—	—	—	—	Cal. – part f. JR. Precondylar ridge
81·4	88·9	81·1	15·7	76·4	58·6	46·0	68·7	72·0	39·3	30·0	9·3	81·3	Cal. P.B. rounded. S equal. JR.
79·2	90·1	—	—	—	67·5	56·7	—	—	—	—	—	—	Cal. br. P.B. upwards with sharp edg
77·7	78·8	71·2	26·7	81·5	43·0	37·6	61·5	78·2	40·3	29·6	10·7	88·9	Cal. br. P.B. flat with sharp edge. JR
76·5	91·1	—	—	76·2	58·5	50·0	67·8	70·2	42·0	23·6	18·4	88·6	Br. cal. – part f. P.B. upwards with
70·0	—	—	17·3	—	—	78·2	—	—	—	—	—	—	Dome + f. P.B. flat with sharp edge.
91·1	97·7	82·6	34·9	86·9	58·9	51·2	63·5	69·6	46·9	29·6	17·3	86·9	Cal. P.B. upwards with sharp edge. S
78·8	88·7	80·2	26·8	80·5	55·2	46·8	66·5	73·3	40·2	27·8	12·4	85·7	Cal. br. P.B. flat with sharp edge. SE
76·7	—	75·4	15·8	79·9	59·1	48·4	66·4	74·1	39·5	27·6	11·9	86·0	Cal. Good teeth. P.B. flat with blunt
76·1	85·5	—	—	—	62·6	54·9	—	—	—	—	—	—	Dome + f. P.B. upwards with sharp
76·8	81·1	74·8	37·0	—	61·7	75·0	—	—	—	—	—	84·9	Cal. br. Teeth good. 4-cusped 2nd mol
72·6	80·9	80·7	28·8	87·5	51·0	50·0	67·1	70·0	42·9	31·3	11·6	81·6	Cal. br. Teeth good. Worn. P.B. flat
78·5	82·3	—	—	—	72·3	49·1	—	—	—	—	—	90·0	Cal. br. P.B. flat with sharp edge. SI
79·9	—	—	—	85·1	—	—	—	—	—	—	—	—	f. S equal. Well developed malar ma
80·8	83·3	75·4	22·2	84·2	60·7	53·1	67·8	72·2	40·0	27·7	12·3	84·5	Cal. P.B. upwards with sharp edge. S
82·9	86·8	79·2	30·7	84·0	62·4	49·5	60·1	75·0	54·9	—	—	—	Cal. br. Teeth good. Worn. P.B. up
87·0	87·1	—	—	—	—	—	—	—	—	—	—	—	Frag. Teeth worn. P.B. upwards wit
—	—	86·9	33·9	—	44·9	—	—	—	—	—	—	—	Frag. Teeth worn. P.B. upwards wit
—	—	79·2	19·5	—	—	—	—	—	—	—	—	—	Frag. 1 carious tooth. 2nd molar 4-c
—	—	93·6	24·3	—	—	—	—	—	—	—	—	—	Frag. P.B. flat with rounded edge.
86·4	91·8	84·3	14·2	74·1	55·0	70·8	60·1	76·9	43·0	34·9	8·1	85·0	Cal. P.B. upwards with sharp edge. S
86·2	94·6	—	—	74·8	58·6	88·2	—	—	—	—	—	—	Cal. Edentulous. P.B. upwards with
75·9	84·1	—	—	83·0	63·2	76·7	59·2	80·8	40·0	34·0	6·0	86·8	Cal. P.B. upwards with blunt edge. S
83·1	89·2	—	—	—	63·6	53·9	—	—	—	—	—	—	Part dome + f. P.B. upwards with b
87·6	93·6	75·0	36·0	86·0	61·5	68·3	62·6	72·3	45·1	33·9	11·2	83·5	Cal. Teeth good. 4-cusped 3rd molar
80·0	80·5	78·7	28·5	76·5	51·8	52·0	67·0	73·9	39·1	29·5	9·6	83·5	Cal. P.B. downwards with blunt edge
													L. side, divided into two externall
77·6	78·8	—	23·4	—	66·2	56·0	—	—	—	—	—	—	Cal. br. Upper part of metopic suture
76·8	87·5	—	—	—	69·3	62·5	—	—	—	—	—	—	Cal. br. Teeth good. P.B. flat with b
—	90·4	—	—	83·4	77·1	51·7	61·8	74·1	44·1	30·4	13·7	87·8	Cal. – part f. P.B. upwards with blu
81·4	87·2	75·3	—	88·6	54·6	63·3	59·1	73·9	47·0	36·0	11·0	84·9	Cal. br. Teeth good. P.B. upwards w
81·3	84·6	82·6	26·5?	88·5	53·6	45·2	61·9	78·0	40·1	29·6	10·5	88·5	Cal. P.B. rounded. SL. J equal.
81·0	83·0	83·2	27·2	75·4	49·8	58·0	65·0	72·9	42·1	25·5	16·6	89·5	Cal. 4-cusped 2nd molar on L. side.
—	89·8	—	—	—	—	58·1	62·5	75·0	42·5	40·0	12·5	77·5	Br. cal. – part f. P.B. upwards with
82·1	—	—	—	—	—	31·6	—	—	—	—	—	—	Br. cal. – part f. P.B. upwards with
82·9	88·5	84·0	28·0	—	41·1	46·6	—	—	—	—	—	—	Cal. br. P.B. upwards with sharp edg
—	—	—	—	—	—	—	—	—	—	—	—	—	Frag. P.B. flat with sharp edge.
—	—	—	25·6	—	—	—	—	—	—	—	—	—	Frag. P.B. upwards with sharp edge.

REMARKS
d. 3rd molars have come down. P.B. upwards with sharp edge. SR. J equal.
rn. 4-cusped 2nd molars. Accessory cusp on 1st molar. R. 3rd molar diseased. P.B. upwards with sharp edge. SL. Hook of lacrymal bone coming forward. Large frontal processes of squama on both sides.
3. flat with sharp edge. S equal. JR. Slight post-coronal depression.
Worn. P.B. flat with blunt edge. S equal. Metopic suture. RP + LF 6 mm. Tiny ossicles at junction of ante and
s with sharp edge.
P.B. rounded. S equal. JR. Torus palatinus.
3. upwards with sharp edge. SR. JR.
3. flat with rounded edge.
upwards with rounded edge. Very strong mastoidal sulcus making super-mastoid crest prominent. Large parieto-. malar marginal process strong. Very broad external pterygoid plate. Metopic suture.
flat with rounded edge.
B. flat with rounded edge. SL. Metopic suture. RP + LF 3 mm.
rn. P.B. rounded. S equal.
l molar L. P.B. upwards with sharp edge. S equal. JL.
B. flat with sharp edge.
B. upwards with sharp edge.
P.B. upwards with blunt edge. Metopic suture. RP + LF about 3 mm.? Well marked spheno-parietal sulcus. Precondylar ridge. Marginal process of L. malar well developed.
S equal. JR.
s with sharp edge. SL.
h sharp edge. JR. Transverse occipital suture 3 cm. on each side.
B. upwards with blunt edge. J equal. Well developed mastoidal groove and petro-mastoid process.
with sharp edge. Slight torus palatinus.
ith sharp edge. SL. JL. Strong malar marginal process on R. Deep canine fossa.
h sharp edge. SR. JR. On L. side, pterygo-spinus bridge and foramen.
B. flat with blunt edge. SR. JR. Torus palatinus.
vards with sharp edge.
4-cusped 2nd molars and R. 3rd molar. P.B. upwards with sharp edge. SL. Torus palatinus. Marked mastoidal groove.
Worn. P.B. flat with sharp edge. S equal.
h sharp edge. SL. Marked mastoidal sulcus and super-mastoid crest.
eloped malar marginal process on L.
ith sharp edge. SL. JR. Small occipital torus.
Worn. P.B. upwards with rounded edge. SL. Marginal process of malars strong.
P.B. upwards with sharp edge.
P.B. upwards with sharp edge.
h. 2nd molar 4-cusped. P.B. flat with blunt edge.
rounded edge.
ith sharp edge. S equal. JL.
B. upwards with rounded edge. SL. JR. Pterygo-spinous bridge and foramen.
ith blunt edge. S equal. JR. Small process on L. pterygoid plate as in 1. Precondylar ridge.
3. upwards with blunt edge.
cusped 3rd molar. P.B. upwards with sharp edge. SL. JL.
s with blunt edge. SR. JR. 4-cusped 2nd molar and minute 4th cusp on 3rd. Porus crotaphitico-buccinatorius on nto two externally; broken on R. side.
of metopic suture persistent. Styliform process on left temporal squama.
P.B. flat with blunt edge. SL.
upwards with blunt edge. SR. JL. Nasal bones and palate diseased.
P.B. upwards with rounded edge. JR.
SL. J equal.
olar on L. side. P.B. flat with blunt edge. SL. JR.
.B. upwards with sharp edge. S equal.
.B. upwards with sharp edge. SR.
ds with sharp edge. 4-cusped 2nd molar. Squamo-mastoidal suture very distinct.
sharp edge.
with sharp edge. Infra-orbital facial suture very distinct.

			Lengths										
No.	Sex	*C*	*F*	*L'*	*L*	*B*	*B'*	*H*	*H'*	*OH*	*LB*	*Q*	*Q'*
153	♀?	—	—	—	—	—	—	—	—	—	—	—	—
154	,,	—	—	—	—	—	—	—	—	—	—	—	—
155	,,	—	—	—	—	—	—	—	—	—	—	—	—
156	,,	—	—	—	—	—	90	—	—	—	—	—	—
157	,,	—	—	—	—	—	94	—	—	—	—	—	—
158	,,	1283·5	177·5	182	179·5	132·5	89	126	125	106·3	98	297	299
159	,,	—	190	—	192	136·5	—	—	131·5	—	100·5	—	—
160	,,	—	183	184·5	184	150	104·5	—	—	112·4	—	318	322
161	,,	1500·0	183	189	187	139	89	127	128	114·3	101	292	294
162	,,	1341·0	177	183	181	138	84·5	125	127	111·3	95·5	309	310
163	,,	1383·0	178	180·5	179·5	141	102·5	130·5	129·5	113·7	102·5	300	300
164	,,	—	—	—	—	—	93·5	—	—	—	—	—	—
165	,,	1253·0	175	178·5	177	136	96	123·5	120	104	90·5	293	296
166	,,	1290·0	174·5	175·5	175·5	133	89·5	125·5	124	101·3	99	284	286
167	,,	1158·0	171	177	176·5	135	89	112·5	111·5	98·8	93	289	288
168	♀	—	—	—	—	—	87	—	—	—	—	—	—
169	,,	—	—	—	—	—	92	—	—	—	—	—	—
170	,,	—	188·5	188·5	188·5	140	96	—	—	101·2	—	285?	290?
171	,,	1309·0	174·5	—	176	132	95·5	—	127	—	97·5	—	—
172	,,	1292·5	179	—	181·5	136	93	—	117	—	96·5	—	—
173	,,	1429·0?	—	—	—	142	90·5	122	122·5?	107·4	92	—	—
174	,,	—	179	179	179·5	—	88	115·5	114·5	102·5	96·5	—	—
175	,,	—	187·5	—	187·5	135·5	99·5	—	—	—	—	—	—
176	,,	1310·5	173	175	174·5	138·5	98	129	128·5	116	97·5	295	302
177	,,	1361·5?	176	176	176·5	137·5	93·5	124·5	123·5	103·4	95·5	293	294
178	,,	—	192	192	192·5	138·5	—	—	—	110	99·5	311	313
179	,,	—	—	—	—	—	92	—	—	—	—	—	—
180	,,	—	—	—	—	—	93	—	—	—	—	—	—
181	,,	—	191·5	—	191·5	138·5	97	—	—	—	—	—	—
182	,,	—	—	—	—	—	98·5	—	—	—	—	—	—
183	,,	1244·5?	173·5	180	178	—	94·5	120·5	119	105·5	104	294??	298??
184	,,	1239·0?	169	171·5	171·5	131	91	125	123·5	101·9	102	298	296
185	,,	1551·0	191·5	—	192	145·5	93·5	—	122·5	—	90	—	—
186	♀?	1423·5	190·5	193	192	143	98·5	125	124·5	111·2	102	310	309
187	♀	1397·0?	186	188	187	138·5	90	136·5	136	113·5	100	307	309
188	,,	1465·5	176·5	176	176	143·5	96·5	131·5	130	116	92	300	301·5
189	,,	1281·0	186·5	189	189	132	91·5	118	116	97·6	95	273	277
190	,,	1365·0	188·5	190	190·5	130	91·5	122·5	121	98·6	98	272	273
191	,,	1278·5	174·5	177	176·5	138·5	95·5	125·5	126·5	104·4	90·5	296	298
192	,,	1458·0	185·5	184	185·5	130·5	95·5	129·5	128·5	109·3	94·5	302	304·5
193	,,	1261·0?	186	187	188	132·5	97·5	124	123·5	102·5	101·5	284?	286?
194	,,	1339·5	186·5	186	185·5	135·5	96	122·5	122·5	112·3	94	289	290
195	,,	—	180·5	—	182·5	—	94·5	—	124·5	—	96·5	—	—
196	,,	1248·0	183	185	185·5	132·5	94	125	123·5	102·5	95	287	289
197	,,	—	181·5	—	181·5	—	94·5	—	—	—	—	—	—
198	,,	1133·5?	179	181·5	180·5	136·5	97·5	123·5	123·5	105·5	100·5	298	300
199	,,	1339·5	181·5	184	184	137·5	97·5	123·5	124	105·2	99·5	298	300
200	,,	1243·0	176·5	180·5	179	132	101	117·5	116·5	104	95·5	294	298
201	,,	1339·5	184	185	185	138	100·5	120	118·5	105·3	91	292	294
202	,,	1049·5	165·5	168	167·5	124·5	85	116·5	115	98·4	86·5	274	278
203	,,	1131·0	166	167	165	129·5	88	121·5	120·5	103·2	89·5	294	299

arringdon Street Skulls.

Arcs										Face				Nos				
Q	*Q'*	*S*	S_1	S_2	S_3	S_1'	S_2'	S_3'	*U*	*PH*	*G'H*	*GB*	*J*	*NH'*	*NH R*	*NH L*	*NB*	*D*
—	—	—	—	—	—	—	—	—	—	16·6	—	—	—	—	—	—	21·9	—
—	—	—	—	—	—	—	—	—	—	20·5?	—	—	—	—	—	—	21·6	—
—	—	—	—	—	—	—	—	—	—	19·0	—	—	—	—	—	—	22·5	—
—	—	—	—	—	—	—	—	—	—	17·6	67·0	87·7	—	47·6	50·2	50·0	23·0	12
—	—	—	—	—	—	—	—	—	—	—	61·9	—	—	45·5?	46·0	46·0	22·1	8
297	299	355	125	119	111	106·5	106	89·5	499	19·5	64·0	—	—	45·9	47·0	44·9	25·1	—
—	—	365·5	121	124·5	120	107·5	114·5	97·5	531	—	—	—	—	—	—	—	—	—
318	322	372	121	135	116	105·5	119	98	536	19·2	67·5	92·0	141	47·5	48·9	48·9	24·5	14
292	294	366	126	116	124	111·5	102·5	104	521	24·2	75·1	93·0	—	50·0	52·0	52·5	22·5	12
309	310	362	119	129	114	108·5	114	99·5	505	17·2?	61·2?	83·5	—	43·8	44·4	44·9	22·6	12
300	300	351·5	120	113	118·5	105·5	101	97	509	21·1?	70·2	88·9	127	48·6	50·0	50·0	24·2	13
—	—	—	130	118	—	114	106·5	—	—	14·0	67·9	85·0	—	52·2	50·0	49·5	20·5	13
293	296	359?	116	138?	105?	104·5	119·5?	87?	500	16·2?	64·0	87·9	—	47·4	48·5	47·3	25·0	14
284	286	347·5?	121	116·5?	110?	107·5	104·5?	94?	496	17·1	71·9	—	—	53·2?	52·1	51·0	23·5	—
289	288	343	111	119	113	101	106	91·5	497	18·2	64·7	90·4	122	46·1?	50·5	50·0	26·5	12
—	—	—	—	—	—	—	—	—	—	12·9	58·2	79·1	—	45·0	43·0	43·3	19·0	8
—	—	—	—	—	—	—	—	—	—	—	66·0	—	—	50·0?	49·1	48·0?	23·6	10
285?	290?	—	122	118·5	—	105	114·5	—	528?	—	—	—	—	—	—	—	—	—
—	—	356	121	125	110	109	110	92·5	499	20·0?	66·0	—	—	56·3?	47·0	—	—	—
—	—	358	119	110	129	105	100	100·5	510	—	—	—	—	—	—	—	—	—
—	—	362?	126?	122	114	108?	108·5	90·5	506	16·3	61·9	83·2	119·5?	44·7	46·5	46·5	23·0	—
—	—	351	123	126	102	107·5	109·5	85·5	—	—	—	—	—	47·6	47·6	47·6	21·0	10
—	—	359	128	126	105	106·5	111·5	86	—	16·4	60·2	95·6	—	43·2	45·1	45·0	26·2	12
295	302	351	117	115	119	104·5	102·5	98	496	21·0	68·5	90·0	122·5	47·5	48·1	48·0	25·0	10
293	294	352	115	131	106	102	115	89·5	501	17·5	62·5	85·5	120	44·9	48·5	47·5	25·4	10
311	313	—	—	141	116	113·5	124	95·5	—	13·1	64·0	90·5	128	50·8	51·0	50·2	23·8	14
—	—	—	123	—	—	108·5	—	—	—	24·5	71·0	88·5	—	46·9	48·9	48·0	21·0	11
—	—	—	127	128	—	111	—	—	—	19·0	62·8	—	—	42·8??	42·8	—	—	—
—	—	377	130	130	117	109·5	112·5	94·5	—	18·0	68·0	—	—	49·2?	52·3	51·0	25·0	10
—	—	—	121	125·5	—	109	112·5	—	—	19·0	66·7	—	—	47·5	47·4	47·5	24·4	12
294??	298??	341	118	119	104	105	106	87·5	497?	16·1	61·0	87·9	—	44·9	45·6	45·8	23·0	10
298	296	335	103	119	113	93	108	93	491?	20·8	70·0	89·6	125·5	50·0	49·5	50·8	25·0	11
—	—	399	135	148	116	119·5	128·5	93·5	537	—	—	—	117	—	—	—	—	—
310	309	386	130	126	130	113·5	112·5	100·5	540	18·5?	67·5?	93·0	124·5	48·9	52·2	51·0	25·5	11
307	309	—	136	139	—	119	122	89?	514	20·1	68·5	—	—	49·4	50·0	49·0	—	—
300	301·5	371	129	123	119	109·5	110	97·5	509	—	67·3	80·3	116·5?	—	48·0	47·3	22·2	11
273	277	372·5	121·5	133	118	105·5	116·5	100	523	16·1	62·6	88·6	126·5	46·5?	47·2	47·8	25·9	10
272	273	369	126	122·5	120·5	109·5	111	96·5	518·5	16·1	68·0	86·0	120·5	—	50·5	49·9	20·0	11
296	298	364	130	123	111	115	110	93·5	500	17·0	65·0	80·9	117·5	48·2	47·1	48·6	19·2	11
302	304·5	383·5	141	135	107·5	118·5	119·5	87·5	518	21·8	74·0	—	—	53·0	53·2	54·0	24·0	11
284?	286?	—	124	119	—	108	109·5	—	507?	20·7	65·0	83·3	122·5	43·5	47·0	45·0	24·5	11
289	290	380	129	124?	127?	108	108?	100?	518	20·0	72·8	89·1	119·5	51·9	52·0	55·0	23·0	
—	—	359	119	122	118	104·5	107·5	94·5	—	—	—	—	—	—	—	—	—	
287	289	366·5	123	128	115·5	108	114	93	505	—	—	—	—	47·4?	48·7	48·2	25·2	11
—	—	369	129	133	107	112·5	121·5	91	498?	19·2	70·1	85·7	—	—	50·9	50·8	22·3	11
298	300	357	134	116	107	117·5	102	90	509	24·3	76·1	81·3	121·5	51·9	54·2	54·2	24·8	11
298	300	365	124	120	121	108·5	110	99·5	515	21·2	67·2	88·3	122	45·8	44·3	44·4	21·9	11
294	298	355	122	120	113	106	106·5	92·5	504	14·6	58·5	86·5	122·5	44·1	45·0	45·0	23·3	
292	294	377	123·5	129·5	124	108·5	114·5	93·5	523	20·1	67·8	81·0	—	47·1	47·0	46·9	24·2	
274	278	337	114	116	107	101·5	104	88	465	17·5	59·5	—	—	41·0	43·4	43·0	21·0	11
294	299	345·5	120	110·5	115	100	98·5	93	476	17·5	65·0	79·1	110·5?	47·0	46·0	46·1	19·6	

TABLE OF ABSOLUTE AND INDICIAL MEASUREMENTS OF TH

Nose							Orbits						Palate and Profile						Foramen	
NH L	*NB*	*DS*	*DC*	*DA*	*SS*	*SC*	O_1R	O_1L	O_2R	O_2L	O_1'	*EOW*	G_1	G_1'	G_2	*GL*	*EB*	*EH*	*fml*	*fmb*
—	21·9	—	—	—	—	—	—	40·4	—	—	—	—	46·8	42·3	39·0??	—	39·0??	8·9?	—	—
—	21·6	—	—	—	—	—	—	—	—	—	—	—	44·3	40·2	31·0	—	30·8	8·9	—	—
—	22·5	—	—	—	—	—	—	42·6	—	—	—	—	47·8	45·0	—	—	—	—	—	—
50·0	23·0	12·9	22·9	33·0	5·3	10·2	40·5	43·1	35·0	35·5	38·8	97·8	—	—	40·5	—	40·5	12·0	—	—
46·0	22·1	8·9	21·8	32·0	3·6	8·1	38·9	—	34·2	—	38·1	—	—	—	—	—	—	—	—	—
44·9	25·1	—	21·0	—	—	6·0	38·0	—	33·0	—	35·9	91·8?	48·4	45·3	38·2	94·5	38·0	15·6	35·3	31·0
—	—	—	—	—	—	—	—	41·7	—	35·1	—	—	—	—	—	—	—	—	43·3	—
48·9	24·5	14·5	29·9	43·2	4·2	10·9	43·5	42·8	35·0	34·2	38·3	104·2	47·0	43·9	41·8	—	41·9	8·8	—	—
52·5	22·5	12·2	20·0	32·0	5·6?	8·5	42·7	43·0	35·5	34·2	42·0	96·2	49·0	46·0	35·5	89·2	35·4	16·5	42·9	34·4
44·9	22·6	12·5	21·0	34·0	3·7	8·0	39·8	41·1	33·0	33·8	37·0	92·5	47·5	42·8	—	89·0	—	—	37·0	28·6
50·0	24·2	13·4	26·6	39·6	5·2	13·0	42·4	42·4	35·4	35·0	39·5	99·0	49·2	45·6	35·2	87·7	35·0	14·1	38·8	29·9
49·5	20·5	13·7	18·4	35·8	5·9	9·0	40·0	40·0	36·1	35·0	37·4	91·1	—	43·8	33·0	—	33·3	11·1	—	—
47·3	25·0	14·4	26·5	36·5	3·9	11·0	38·7	38·6	29·5	30·5	34·5	94·5	41·8	40·0	39·0	86·0	39·0	9·9	31·4	24·5
51·0	23·5	—	19·2	—	5·4	8·0	41·2	—	34·0	—	39·5	94·9??	—	—	—	94·6	—	—	—	—
50·0	26·5	12·8	23·2	34·9	3·8	10·0	41·0	40·0	32·0	33·0	38·5	93·8	45·1	43·2	36·5	87·8	36·6	10·1	32·9	31·0
43·3	19·0	8·1	16·9	27·8	1·9	4·9	36·7	37·0	31·0	30·0	35·1	85·5	47·6	45·0	—	—	—	—	—	—
48·0?	23·6	10·9	20·0	31·4	4·3	8·9	39·0	—	34·0	—	38·2	91·9	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	40·3	—	35·1	—	40·1	96·1?	—	—	—	—	—	—	—	—
—	—	—	17·5	—	—	—	—	—	—	—	—	—	—	—	—	95·8	—	—	34·9	28·8
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	35·1	29·9
46·5	23·0	—	18·0	—	—	9·0	39·0	39·6	31·1	31·1	39·0	89·8	44·2	41·8	38·5	87·8	38·6	10·8	35·0	27·5
47·6	21·0	10·9	18·2	31·1	4·8	8·5	—	40·0	—	35·2	—	—	41·5	38·4	—	—	—	—	33·5	26·5
45·0	26·2	12·3	28·0	39·4	3·1	11·0	39·5	38·8	29·2	30·3	37·0	99·1	49·3	45·0	40·4	—	40·5	8·5	—	—
48·0	25·0	10·7	21·3	30·5	4·2	10·2	41·7	41·7	35·6	36·0	40·5	98·8	46·9	43·9	40·0	91·2	40·0	9·9	33·1	26·4
47·5	25·4	10·8	21·8	31·2	4·6	10·0	41·0	41·0	34·2	33·8	39·0	95·1	50·0	46·0	39·4	89·8	39·3	10·8	34·1	28·1
50·2	23·8	14·0	20·6	35·2?	5·3	8·5	42·0	41·0	32·5	31·5	38·0	96·6	45·4	42·7	39·1	94·1	39·0	12·2	38·5	30·0
48·0	21·0	11·2	21·0	32·0	3·9	9·4	39·0	39·0	35·0	34·0	37·8	91·4	46·5	42·2	36·3	88·6	36·5	10·7	—	—
—	—	—	—	—	—	—	38·0	—	32·4	—	36·5	—	—	—	—	—	—	—	—	—
51·0	25·0	10·7	24·0	33·0	4·6	10·2	42·0	—	34·1	—	40·0	97·1?	49·2	46·8	—	42·0?	42·0??	12·0?	—	—
47·5	24·4	12·8	22·0	36·7	5·9	10·2	—	—	31·8	—	—	—	48·3	45·9	—	—	—	—	—	—
45·8	23·0	10·3	20·5	30·0	4·0	9·7	42·5	42·5	32·0	31·7	42·4	97·1	49·2	44·6	35·2	99·5	35·2	10·0	35·6	26·1
50·8	25·0	11·5	21·0	33·7	3·3	9·0	40·0	40·0	34·4	34·7	38·5	94·8	49·8	45·0	—	97·6	—	—	36·0	29·2
—	—	—	—	—	4·0	8·8	—	—	33·2	—	—	—	—	—	—	—	—	—	31·4	27·6
51·0	25·5	13·0	20·0	29·5	5·6	12·2	42·8	42·5	37·0	37·0	41·4	98·2	—	—	—	90·2?	—	—	31·8	30·3
49·0	—	—	20·0	—	—	—	40·6	—	35·7	—	40·2	90·8?	42·7	38·8	38·5??	82·1	38·5??	11·5?	—	28·6
47·3	22·2	11·2	22·0	34·0	4·1	8·0	38·8	40·0	35·0	35·5	36·0	91·0	—	43·1	29·8	82·8	30·0	9·8	34·0	30·1
47·8	25·9	10·4	21·5	31·5	4·1	10·4	41·6	41·0	33·7	33·5	40·4	100·1	—	44·8	41·2	102·8	41·0	8·1?	35·1	28·8
49·9	20·0	11·8	19·9	31·2	4·2	8·2	41·4	41·4	36·5	36·2	38·1	93·0	42·8	42·2	36·1?	90·4	36·0?	8·8	39·5	34·1
48·6	19·2	12·9	16·2	30·0	3·3	6·0	41·1	41·3	35·2	35·2	39·2	93·8	42·1	38·2	—	80·2	—	—	32·5	27·1
54·0	24·0	11·3	22·1	30·5	2·3	6·1	—	42·3	—	38·2	—	97·0?	43·5	41·1	35·9	83·1	35·8	12·5	34·1	28·5
45·0	24·5	12·8	22·8	33·1	4·2	9·8	40·4	40·3	34·3	34·6	41·1	98·1	47·0	43·8	—	92·9	—	—	—	—
55·0	23·0	9·9	21·0	30·0	2·3	6·0	39·7	38·8	34·2	35·8	37·2	93·0	46·0	43·8	—	82·5	—	—	33·0	29·0
—	—	—	—	—	4·2	6·0	—	41·5	—	34·5	—	97·0?	—	—	—	—	—	—	40·6	—
48·2	25·2	11·1	20·6	33·1	5·7	10·2	—	40·9	—	33·4	—	96·0?	—	—	—	—	—	—	37·8	30·1
50·8	22·3	11·7	19·6	31·8	4·7	10·0	41·2	44·7	34·2	32·6	39·6	95·8	44·1	41·2	—	—	—	—	—	—
54·2	24·8	13·7	23·9	37·0	4·1	8·4	39·2	39·8	36·6	36·0	37·2	91·2	49·6	46·7	43·2	93·0	43·2	18·0	35·9	28·2
44·4	21·9	12·8	24·0	34·1	4·8	10·0	38·8	39·9	32·6	32·6	38·1	98·1	54·8	51·5	42·0	98·2	42·0	15·0	34·2	28·0
45·0	23·3	8·3	21·0	27·0	3·0	9·2	40·0	40·1	31·4	32·0	39·0	94·9	43·3	40·6	—	91·0	—	—	32·9	25·0
46·9	24·2	9·4	25·0	33·0	3·1	10·6	41·0	42·0	34·8	34·0	39·5	99·0	47·0	44·1	37·6?	92·8	37·5	9·9?	34·8	27·2
43·0	21·0	11·3	19·9	33·0	5·0	9·5	—	39·8	35·0?	35·3	38·0	90·9	42·0	41·2	34·1?	78·2	34·0?	4·5?	32·2	27·5
46·1	19·6	9·9	18·0	27·9	2·1	6·3	36·0	38·0	31·6	31·6	35·0	85·9	47·5	45·2	34·8	87·0	35·0	8·4	31·4	28·9

EMENTS OF THE INDIVIDUAL CRANIA. (LENGTHS IN MILLIMETRES.)

e		Foramen		Indices														
EB	*EH*	*fml*	*fmb*	*Oc.I.*	*B/L'*	*H/L'*	*B/L*	*H/L*	*B/H*	*H'/L*	*B/H'*	$\frac{B-H'}{L}$	*G'H/GB*	$\frac{NB}{NH}$ *R*	$\frac{NB}{NH}$ *L*	$\frac{O_2}{O_1}$ *R*	$\frac{O_2}{O_1}$ *L*	O_2/O_1'
39·0??	8·9?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30·8	8·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
40·5	12·0	—	—	—	—	—	—	—	—	—	—	—	76·4	45·8	46·0	86·4	82·4	90·2
—	—	—	—	—	—	—	—	—	—	—	—	—	—	48·0	48·0	87·9	—	89·8
38·0	15·6	35·3	31·0	57·5	72·8	69·2	73·8	70·2	105·2	69·6	106·0	4·2	—	53·4	55·9	86·8	—	91·9
—	—	43·3	—	58·0	—	—	71·1	—	—	68·5	103·8	2·6	—	—	—	—	84·2	—
41·9	8·8	—	—	61·3	81·3	—	81·5	—	—	—	—	—	73·4	50·1	50·1	80·5	79·9	91·4
35·4	16·5	42·9	34·4	60·6	73·5	67·2	74·3	67·9	109·4	68·4	108·6	5·9	80·8	43·3	42·9	83·1	79·5	84·5
—	—	37·0	28·6	65·5	75·4	68·3	76·2	69·1	110·4	70·2	108·7	6·0	73·3	50·9	50·3	82·9	82·2	89·2
35·0	14·1	38·8	29·9	58·5	78·1	72·3	78·6	72·7	108·0	72·1	108·9	6·5	79·0	48·4	48·4	83·5	82·5	89·6
33·3	11·1	—	—	—	—	—	—	—	—	—	—	—	79·9	41·0	41·4	90·2	87·5	96·5
39·0	9·9	31·4	24·5	59·5	76·2	69·2	76·8	69·8	110·1	67·8	113·3	9·0	72·8	51·5	52·9	76·2	79·0	85·5
—	—	—	—	62·7	75·8	71·5	75·8	71·5	106·0	70·7	107·3	5·1	—	45·1	46·1	82·5	—	86·1
36·6	10·1	32·9	31·0	57·8	76·3	63·6	76·5	63·7	120·0	63·2	121·1	13·3	71·6	52·5	53·0	78·0	82·5	83·1
—	—	—	—	—	—	—	—	—	—	—	—	—	73·6	44·2	43·9	84·5	81·1	88·3
—	—	—	—	—	—	—	—	—	—	—	—	—	—	48·1	49·2	87·2	—	89·0
—	—	—	—	—	74·3	—	74·3	—	—	—	—	—	—	—	—	87·1	—	87·5
—	—	34·9	28·8	60·9	—	—	75·0	—	—	72·2	103·9	2·8	—	—	—	—	—	—
—	—	35·1	29·9	55·7	—	—	74·9	—	—	64·5	116·2	10·4	—	—	—	—	—	—
38·6	10·8	35·0	27·5	56·6	—	—	—	—	116·4	—	115·9	—	74·4	49·5	49·5	79·7	78·5	79·7
—	—	33·5	26·5	60·5	—	64·5	—	64·3	—	63·8	—	—	—	44·1	44·1	—	88·0	—
40·5	8·5	—	—	58·6	—	—	72·3	—	—	—	—	—	63·0	58·1	58·2	73·9	78·1	78·9
40·0	9·9	33·1	26·4	59·0	79·1	73·7	79·4	73·9	107·4	73·6	107·8	5·8	76·1	52·0	52·1	85·4	86·3	87·9
39·3	10·8	34·1	28·1	61·3	78·1	70·7	77·9	70·5	110·4	70·0	111·3	7·9	73·1	52·4	53·5	83·4	82·4	87·7
39·0	12·2	38·5	30·0	59·0	72·1	—	71·9	—	—	—	—	—	70·7	46·7	47·4	77·4	76·8	85·5
36·5	10·7	—	—	—	—	—	—	—	—	—	—	—	80·2	42·9	43·7	89·7	87·2	92·6
—	—	—	—	—	—	—	—	—	—	—	—	—	—	-·-	—	85·3	—	88·8
42·0??	12·0?	—	—	57·6	—	—	72·3	—	—	—	—	—	—	47·8	49·0	81·2	—	85·3
—	—	—	—	—	—	—	—	—	—	—	—	—	—	51·5	51·4	—	—	—
35·2	10·0	35·6	26·1	60·9	—	66·9	—	67·7	—	66·9	—	—	69·4	50·4	50·2	75·3	74·6	75·5
—	—	36·0	29·2	59·0	76·4	72·9	76·4	72·9	104·8	72·0	106·1	4·4	78·1	50·5	49·2	86·0	86·7	89·4
—	—	31·4	27·6	57·5	—	—	75·8	—	—	63·8	118·8	12·0	—	—	—	—	—	—
—	—	31·8	30·3	55·4	74·1	64·8	74·5	65·1	114·4	64·8	114·9	9·7	72·6	48·9	50·0	86·4	87·1	89·4
38·5??	11·5?	—	28·6	—	73·7	72·6	74·1	73·0	101·5	72·7	101·8	1·4	—	—	—	87·9	—	88·8
30·0	9·8	34·0	30·1	58·6	81·5	74·7	81·5	74·7	109·1	73·9	110·4	7·6	83·8	46·3	46·9	90·2	88·8	97·2
41·0	8·1?	35·1	28·8	61·7	69·8	62·4	69·8	62·4	111·9	61·4	113·8	8·4	70·7	54·9	54·2	81·0	81·7	83·4
36·0?	8·8	39·5	34·1	57·1	68·4	64·5	68·2	64·3	106·1	63·5	107·4	4·7	79·1	39·6	40·1	88·2	87·4	95·8
—	—	32·5	27·1	61·0	78·2	70·9	78·5	71·1	110·4	71·7	109·5	6·8	80·3	40·8	39·5	85·6	85·2	89·8
35·8	12·5	34·1	28·5	58·1	70·9	70·4	70·4	69·8	100·8	69·3	101·6	1·1	—	45·1	44·4	—	90·3	—
—	—	—	—	—	70·9	66·3	70·5	66·0	106·9	65·7	107·3	4·8	78·0	52·1	54·4	84·9	85·9	83·5
—	—	33·0	29·0	56·2	72·8	65·9	73·0	66·0	110·6	66·0	110·6	7·0	81·7	44·2	41·8	86·1	92·3	91·9
—	—	40·6	—	57·1	—	—	—	—	—	68·2	—	—	—	—	—	—	83·1	—
—	—	37·8	30·1	57·4	71·6	67·6	71·4	67·4	106·0	66·6	107·3	4·8	—	51·7	52·3	—	81·7	—
—	—	—	—	62·1	—	—	—	—	—	—	—	—	81·8	43·8	43·9	83·0	72·9	86·4
43·2	18·0	35·9	28·2	60·9	75·2	68·0	75·6	68·4	110·5	68·4	110·5	7·2	93·6	45·8	45·8	93·4	90·5	98·4
42·0	15·0	34·2	28·0	58·9	74·7	67·1	74·7	67·1	111·3	67·4	110·9	7·3	76·1	49·4	49·3	84·0	81·7	85·6
—	—	32·9	25·0	58·5	73·1	65·1	73·7	65·6	112·3	65·1	113·3	8·6	67·6	51·8	51·8	78·5	79·8	80·5
37·5	9·9?	34·8	27·2	54·6	74·6	64·9	74·6	64·9	115·0	64·1	116·5	10·5	83·7	51·5	51·6	84·9	81·0	88·1
34·0?	4·5?	32·2	27·5	58·9	74·1	69·3	74·3	69·6	106·9	68·7	108·3	5·6	—	48·4	48·8	—	88·7	92·1
35·0	8·4	31·4	28·9	57·7	77·5	72·8	78·5	73·6	106·6	73·0	107·5	5·5	82·2	42·6	42·5	87·8	83·2	90·3

O_1	O_2/O_1 L	O_2/O_1'	G_2/G_1	*EH/EB*	*fmb/fml*	*DS/DC*	*SS/SC*	Angles (in degrees) $N\angle$	$A\angle$	$B\angle$	θ_1	θ_2	$P\angle$	
-	—	—	83·3	22·8	—	—	—	—	—	—	—	—	—	Frag. P.B. upwards with sharp edge. Slight to normal.
-	—	—	70·0	28·9	—	—	—	—	—	—	—	—	—	Frag. P.B. upwards with blunt edge.
-	—	—	—	—	—	—	—	—	—	—	—	—	—	Frag. P.B. upwards with rounded edge. Toru
·4	82·4	90·2	—	29·6	—	56·3	52·0	—	—	—	—	—	—	Frag. P.B. upwards with sharp edge. Distinc
·9	—	89·8	—	—	—	40·8	44·4	—	—	—	—	—	—	Frag. P.B. flat with blunt edge.
·8	—	91·9	78·9	41·1	87·8	—	—	67·6	73·9	38·5	25·6	12·9	86·8	Cal. br. Teeth good. 4-cusped 2nd molar. Oc
-	84·2	—	—	—	—	—	—	—	—	—	—	—	—	Br. cal. – part f. L. 3rd molar just coming c
·5	79·9	91·4	88·9	21·0	—	48·5	38·5	—	—	—	—	—	82·5	Cal. br. S equal. Signs of 4th cusp on 2nd m
·1	79·5	84·5	72·4	46·6	80·2	61·0	65·9	58·8	75·3	45·9	33·3	12·6	87·9	Cal. P.B. upwards with sharp edge. SR. JR
·9	82·2	89·2	—	—	77·3	59·5	46·3	64·8	76·8	38·4	28·3	10·1	86·9?	Cal. P.B. upwards with blunt edge. SR. JL
·5	82·5	89·6	71·5	40·3	77·1	50·4	40·0	57·0	80·5	42·5	36·1	6·4	86·9	Cal. P.B. upwards with blunt edge. S equal bulging in temporal fossa. Very slight po
·2	87·5	96·5	—	33·1	—	74·5	65·6	—	—	—	—	—	—	Cal. br. P.B. upwards with sharp edge. R. 3
·2	79·0	85·5	93·3	25·4	78·0	54·3	35·5	64·9	72·9	42·2	28·9	13·3	86·2	Cal. Teeth good. Worn. P.B. flat with blun
·5	—	86·1	—	—	—	—	67·5	64·8	71·8	43·4	32·7	10·7	82·5	Cal. br. P.B. upwards with blunt edge. SR. T
·0	82·5	83·1	80·9	27·6	94·2	55·2	38·0	64·6	73·7	41·7	28·8	12·9	86·6	Cal. P.B. downwards with blunt edge. SR.
·5	81·1	88·3	—	—	—	47·9	38·8	—	—	—	—	—	—	Frag. Old. P.B. flat with blunt edge. Deep
·2	—	89·0	—	—	—	54·5	48·3	—	—	—	—	—	—	Frag. Old. P.B. downwards with sharp edg
·1	—	87·5	—	—	—	—	—	—	—	—	—	—	—	Br. cal. – part f.
-	—	—	—	—	82·5	—	—	68·3	71·7	40·0	—	—	—	Br. cal. – part f. P.B. upwards with sharp
-	—	—	—	—	85·2	—	—	—	—	—	—	—	—	Cal. – part f. SR. Metopic suture. LF + R
·7	78·5	79·7	87·1	28·0	78·6	—	—	66·0	73·9	40·1	24·0	16·1	90·0	Cal. br. Young adult. Teeth good. Canines rounded edge. SL. JL.
-	88·0	—	—	—	79·1	59·3	56·5	—	—	—	—	—	—	Br. cal. – part f. P.B. upwards with sharp
·9	78·1	78·9	61·7	21·0	—	43·9	28·2	—	—	—	—	—	—	Cal. br. Teeth good. Worn. P.B. flat with r
·4	86·3	87·9	85·3	24·7	79·8	50·2	41·2	63·1	74·9	42·0	35·2	6·8	81·7	Cal. L. 3rd molar just coming down. P.B. f cephaly. Ossicle of λ replacing apex of s
·4	82·4	87·7	78·8	27·5	82·4	49·5	46·0	65·1	75·8	39·1	31·4	7·7	83·5	Cal. br. 4-cusped 2nd molar. P.B. downwar
·4	76·8	85·5	86·1	30·5	77·9	68·0	62·4	66·1	75·7	38·2	27·3	10·9	86·6	Cal. br. P.B. flat with sharp edge. JL. Slig
·7	87·2	92·6	78·1	29·3	—	53·3	41·5	—	—	—	—	—	—	Cal. br. Teeth good. Worn. 4-cusped 2nd
·3	—	88·8	—	—	—	—	—	—	—	—	—	—	—	Br. cal. – part f. P.B. upwards with sharp
·2	—	85·3	—	28·6	—	44·6	45·1	—	—	—	—	—	—	Cal. br. P.B. upwards with sharp edge. Post
-	—	—	—	—	—	58·2	57·8	—	—	—	—	—	—	Br. cal. – part f. P.B. upwards with sharp
·3	74·6	75·5	71·5	27·8	73·3	50·2	41·2	68·6	76·8	34·6	24·4	10·2	87·0	Cal. br. Teeth good. P.B. flat with blunt e
·0	86·7	89·4	—	—	81·1	54·8	36·7	65·9	73·1	41·0	29·1	11·9	85·0	Cal. br. P.B. upwards with blunt edge; dou
-	—	—	—	—	87·9	—	45·5	—	—	—	—	—	—	Cal. – part f. JR. Ossicle in L. lambdoid
·4	87·1	89·4	—	—	95·3	65·0	45·9	60·0	79·0	41·0	27·5	13·5	92·5	Cal. Almost edentulous. P.B. upwards wit
·9	—	88·8	90·2	29·9	—	—	—	54·5	83·5	42·0	33·5	8·5	92·0	Cal. – part f. P.B. upwards with sharp ed foramen spinosum, a small bony arc enc
·2	88·8	97·2	—	32·6	88·5	50·9	51·3	59·9	75·2	44·9	36·1	8·8	84·0	Cal. 1st molar 3-cusped. P.B. upwards wit Cribriform tympanic plate on R.
·0	81·7	83·4	—	19·8	82·0	48·4	39·4	78·4	65·1	36·5	19·4	17·1	82·2	Cal. P.B. upwards with sharp edge. SR. J
·2	87·4	95·8	84·3	24·4	86·3	59·3	51·2	62·9	75·1	42·0	31·7	10·3	85·4	Cal. P.B. flat with sharp edge. J equal. S
·6	85·2	89·8	—	—	83·4	79·6	55·0	59·4	76·4	44·2	33·6	10·6	87·0	Cal. 4-cusped 2nd molar on R. P.B. upw well developed. Marked Sylvian groove
—	90·3	—	82·5	34·9	83·6	51·1	37·7	57·5	73·9	48·6	31·0	17·6	91·5	Cal. P.B. flat with blunt edge. SR. JR. S mastoid foramen.
·9	85·9	83·5	—	—	—	56·1	42·9	63·1	78·1	38·8	33·0	5·8	83·9	Cal. br. P.B. upwards with rounded edge.
·1	92·3	91·9	—	—	87·9	47·1	38·3	57·4	74·6	48·0	33·5	14·5	89·1	Cal. P.B. upwards with sharp edge. SR. J ossicle in parietal notch of temporal bo complete on L. Well developed malar r
—	83·1	—	—	—	—	—	70·0	—	—	—	—	—	—	Br. cal. – part f.
—	81·7	—	—	—	79·6	53·9	55·9	—	—	—	—	—	—	Cal. – part f. P.B. upwards with rounded
·0	72·9	86·4	—	—	—	59·7	47·0	—	—	—	—	—	—	Cal. br. Bone 9 mm. thick. P.B. upwards
·4	90·5	98·4	87·1	41·9	78·6	57·3	48·8	61·8	72·2	46·0	29·1	16·9	89·1	Cal. br. 1 carious tooth. P.B. upwards with Outer palate bridge on L.
·0	81·7	85·6	76·6	35·7	81·9	53·3	48·0	69·0	71·2	39·8	27·1	11·7	83·9	Cal. P.B. upwards with blunt edge. S equ
·5	79·8	80·5	—	—	76·0	39·5	32·6	67·4	76·1	36·5	24·7	11·8	87·9	Cal. P.B. upwards with blunt edge. SR. on R. Depression of obelion.
·9	81·0	88·1	80·0	26·5	78·2	37·6	29·2	69·6	67·2	43·2	29·0	14·2	81·4	Cal. P.B. flat with blunt edge. S equal. J
—	88·7	92·1	81·2	13·2	85·4	56·8	52·6	61·5	76·6	41·9	32·7	9·2	85·8	Cal. – part f. P.B. upwards with sharp e
·8	83·2	90·3	73·3	24·0	92·0	55·0	33·3	66·5	70·3	43·2	27·8	15·4	85·7	Cal. 2 carious teeth. P.B. upwards with sh of L. tympanic plate. L. post-condyla

O_2/O_1 L	O_2/O_1'	G_2/G_1	EH/EB	fmb/fml	DS/DC	SS/SC	Angles (in degrees) $N\angle$	$A\angle$	$B\angle$	θ_1	θ_2	$P\angle$	Rem
—	—	83·3	22·8	—	—	—	—	—	—	—	—	—	Frag. P.B. upwards with sharp edge. Slight torus palatinus. R. can normal.
—	—	70·0	28·9	—	—	—	—	—	—	—	—	—	Frag. P.B. upwards with blunt edge.
—	—	—	—	—	—	—	—	—	—	—	—	—	Frag. P.B. upwards with rounded edge. Torus palatinus (? exostos
82·4	90·2	—	29·6	—	56·3	52·0	—	—	—	—	—	—	Frag. P.B. upwards with sharp edge. Distinct facial infra-orbital
—	89·8	—	—	—	40·8	44·4	—	—	—	—	—	—	Frag. P.B. flat with blunt edge.
—	91·9	78·9	41·1	87·8	—	—	67·6	73·9	38·5	25·6	12·9	86·8	Cal. br. Teeth good. 4-cusped 2nd molar. Ossicle of pterion, R.
84·2	—	—	—	—	—	—	—	—	—	—	—	—	Br. cal. – part f. L. 3rd molar just coming down. Metopic suture
79·9	91·4	88·9	21·0	—	48·5	38·5	—	—	—	—	—	82·5	Cal. br. S equal. Signs of 4th cusp on 2nd molars. Traces of meto
79·5	84·5	72·4	46·6	80·2	61·0	65·9	58·8	75·3	45·9	33·3	12·6	87·9	Cal. P.B. upwards with sharp edge. SR. JR. Spheno-parietal sut
82·2	89·2	—	—	77·3	59·5	46·3	64·8	76·8	38·4	28·3	10·1	86·9?	Cal. P.B. upwards with blunt edge. SR. JL. Frontal process to
82·5	89·6	71·5	40·3	77·1	50·4	40·0	57·0	80·5	42·5	36·1	6·4	86·9	Cal. P.B. upwards with blunt edge. S equal. JR. Metopic sutu bulging in temporal fossa. Very slight post-coronal depression.
87·5	96·5	—	33·1	—	74·5	65·6	—	—	—	—	—	—	Cal. br. P.B. upwards with sharp edge. R. 3rd molar 13 mm. bro
79·0	85·5	93·3	25·4	78·0	54·3	35·5	64·9	72·9	42·2	28·9	13·3	86·2	Cal. Teeth good. Worn. P.B. flat with blunt edge. SR. JR. Ves
—	86·1	—	—	—	—	67·5	64·8	71·8	43·4	32·7	10·7	82·5	Cal. br. P.B. upwards with blunt edge. SR. Traces of upper part of
82·5	83·1	80·9	27·6	94·2	55·2	38·0	64·6	73·7	41·7	28·8	12·9	86·6	Cal. P.B. downwards with blunt edge. SR. JL. Strong marginal
81·1	88·3	—	—	—	47·9	38·8	—	—	—	—	—	—	Frag. Old. P.B. flat with blunt edge. Deep canine fossa.
—	89·0	—	—	—	54·5	48·3	—	—	—	—	—	—	Frag. Old. P.B. downwards with sharp edge.
—	87·5	—	—	—	—	—	—	—	—	—	—	—	Br. cal. – part f.
—	—	—	—	82·5	—	—	68·3	71·7	40·0	—	—	—	Br. cal. – part f. P.B. upwards with sharp edge. Parieto-frontal
—	—	—	—	85·2	—	—	—	—	—	—	—	—	Cal. – part f. SR. Metopic suture. LF + RP 5 mm. Post-obelial
78·5	79·7	87·1	28·0	78·6	—	—	66·0	73·9	40·1	24·0	16·1	90·0	Cal. br. Young adult. Teeth good. Canines delayed, and coming rounded edge. SL. JL.
88·0	—	—	—	79·1	59·9	56·5	—	—	—	—	—	—	Br. cal. – part f. P.B. upwards with sharp edge. SR. Nearly ed
78·1	78·9	61·7	21·0	—	43·9	28·2	—	—	—	—	—	—	Cal. br. Teeth good. Worn. P.B. flat with rounded edge. Metopic cephaly. Ossicle of λ replacing apex of squama. Frontal proce
86·3	87·9	85·3	24·7	79·8	50·2	41·2	63·1	74·9	42·0	35·2	6·8	81·7	Cal. L. 3rd molar just coming down. P.B. flat with blunt edge.
82·4	87·7	78·8	27·5	82·4	49·5	46·0	65·1	75·8	39·1	31·4	7·7	83·5	Cal. br. 4-cusped 2nd molar. P.B. downwards with rounded edge
76·8	85·5	86·1	30·5	77·9	68·0	62·4	66·1	75·7	38·2	27·3	10·9	86·6	Cal. br. P.B. flat with sharp edge. JL. Slight bathrocephaly.
87·2	92·6	78·1	29·3	—	53·3	41·5	—	—	—	—	—	—	Cal. br. Teeth good. Worn. 4-cusped 2nd molar. P.B. upwards
—	88·8	—	—	—	—	—	—	—	—	—	—	—	Br. cal. – part f. P.B. upwards with sharp edge.
—	85·3	—	28·6	—	44·6	45·1	—	—	—	—	—	—	Cal. br. P.B. upwards with sharp edge. Post-coronal depression. S
—	—	—	—	—	58·2	57·8	—	—	—	—	—	—	Br. cal. – part f. P.B. upwards with sharp edge. Post-sagittal g
74·6	75·5	71·5	27·8	73·3	50·2	41·2	68·6	76·8	34·6	24·4	10·2	87·0	Cal. br. Teeth good. P.B. flat with blunt edge. JL. Flattening
86·7	89·4	—	—	81·1	54·8	36·7	65·9	73·1	41·0	29·1	11·9	85·0	Cal. br. P.B. upwards with blunt edge; double on L. side. JR.
—	—	—	—	87·9	—	45·5	—	—	—	—	—	—	Cal. – part f. JR. Ossicle in L. lambdoid suture 16 × 20 mm. F
87·1	89·4	—	—	95·3	65·0	45·9	60·0	79·0	41·0	27·5	13·5	92·5	Cal. Almost edentulous. P.B. upwards with sharp edge. SR. JL
—	88·8	90·2	29·9	—	—	—	54·5	83·5	42·0	33·5	8·5	92·0	Cal. – part f. P.B. upwards with sharp edge. SR. JR. Frontal foramen spinosum, a small bony arc enclosing foramen directe
88·8	97·2	—	32·6	88·5	50·9	51·3	59·9	75·2	44·9	36·1	8·8	84·0	Cal. 1st molar 3-cusped. P.B. upwards with sharp edge. JL. Me Cribriform tympanic plate on R.
81·7	83·4	—	19·8	82·0	48·4	39·4	78·4	65·1	36·5	19·4	17·1	82·2	Cal. P.B. upwards with sharp edge. SR. JR. Occipital torus. S
87·4	95·8	84·3	24·4	86·3	59·3	51·2	62·9	75·1	42·0	31·7	10·3	85·4	Cal. P.B. flat with sharp edge. J equal. Strong marginal process
85·2	89·8	—	—	83·4	79·6	55·0	59·4	76·4	44·2	33·6	10·6	87·0	Cal. 4-cusped 2nd molar on R. P.B. upwards with sharp edge. well developed. Marked Sylvian groove. Sutures indistinct.
90·3	—	82·5	34·9	83·6	51·1	37·7	57·5	73·9	48·6	31·0	17·6	91·5	Cal. P.B. flat with blunt edge. SP JR. Slight post-coronal dep mastoid foramen.
85·9	83·5	—	—	—	56·1	42·9	63·1	78·1	38·8	33·0	5·8	83·9	Cal. br. P.B. upwards with rounded edge. S equal.
92·3	91·9	—	—	87·9	47·1	38·3	57·4	74·6	48·0	33·5	14·5	89·1	Cal. P.B. upwards with sharp edge. SR. JR. Post-coronal depre ossicle in parietal notch of temporal bone, 15 mm. Ossicle o complete on L. Well developed malar marginal process on R.
83·1	—	—	—	—	—	70·0	—	—	—	—	—	—	Br. cal. – part f.
81·7	—	—	—	79·6	53·9	55·9	—	—	—	—	—	—	Cal. – part f. P.B. upwards with rounded edge. JR.
72·9	86·4	—	—	—	59·7	47·0	—	—	—	—	—	—	Cal. br. Bone 9 mm. thick. P.B. upwards with sharp edge. SR.
90·5	98·4	87·1	41·9	78·6	57·3	48·8	61·8	72·2	46·0	29·1	16·9	89·1	Cal. br. 1 carious tooth. P.B. upwards with sharp edge. S equal. Outer palate bridge on L.
81·7	85·6	76·6	35·7	81·9	53·3	48·0	69·0	71·2	39·8	27·1	11·7	83·9	Cal. P.B. upwards with blunt edge. S equal. JL. Ossicle of pte
79·8	80·5	—	—	76·0	39·5	32·6	67·4	76·1	36·5	24·7	11·8	87·9	Cal. P.B. upwards with blunt edge. SR. JL. Slight post-coron on R. Depression of obelion.
81·0	88·1	80·0	26·5	78·2	37·6	29·2	69·6	67·2	43·2	29·0	14·2	81·4	Cal. P.B. flat with blunt edge. S equal. JR. Ossicle of pterion
88·7	92·1	81·2	13·2	85·4	56·8	52·6	61·5	76·6	41·9	32·7	9·2	85·8	Cal. – part f. P.B. upwards with sharp edge. S equal. JR. Os
83·2	90·3	73·3	24·0	92·0	55·0	33·3	66·5	70·3	43·2	27·8	15·4	85·7	Cal. 2 carious teeth. P.B. upwards with sharp edge. SR. JL. To of L. tympanic plate. L. post-condylar foramen 5 mm. acros

	REMARKS
	palatinus. R. canine delayed, coming down on palatine side of lateral incisor. L. canine
	latinus (? exostosis).
	cial infra-orbital suture. Small process on pterygoid plate R. and L. as in 1.
	e of pterion, R. P.B. flat with blunt edge. SR. JL.
	. Metopic suture in line with interparietal.
	s. Traces of metopic suture. Slight palatine torus. Mastoidal groove well marked.
	pheno-parietal suture 7 mm. Sylvian groove is squamo-parietal.
	ontal process to parietal.
	R. Metopic suture in line with interparietal. Frontal process to L. parietal. Frontal
	ronal depression.
	nolar 13 mm. broad. Ante-posterior 7 mm.
	ge. SR. JR. Vestiges of ossicles of λ. Pronounced occipital flattening.
	s of upper part of metopic suture. RF + LP 4 mm. Spine of sphenoid pierced transversely.
	Strong marginal process on malar. Parieto-frontal overlap. Flattening of obelion.
	ne fossa.
	. Parieto-frontal overlap.
	mm. Post-obelial depression.
	yed, and coming down behind 2nd incisors. 4-cusped 2nd molar. P.B. downwards with
	. SR. Nearly edentulous.
	ed edge. Metopic suture. No noticeable deviation of cruciform sutures. Slight bathro-
	na. Frontal process on L. parietal. Infra-orbital facial suture distinct.
	ith blunt edge. SR. JR. Frontal process of squama, 18 mm. Torus palatinus.
	ith rounded edge. JR. Os triangulare on R. side.
	athrocephaly.
	r. P.B. upwards with sharp edge. SL.
	e.
	nal depression. Slight bathrocephaly. Median palatine groove Posterior sagittal ossicle.
	e. Post-sagittal groove.
	JL. Flattening of obelion.
	on L. side. JR. Double ossicle of bregma. Metopic suture. 2 precondylar growths.
	re 16 × 20 mm. Flattening of obelion.
	rp edge. SR. JL.
	R. JR. Frontal process to parietal. On R. side, between the sphenoidal spine and the
	g foramen directed from behind forwards.
	rp edge. JL. Metopic suture. LF + RP 3 mm. Pterygoid process as in 1. Inion distinct.
	Occipital torus. Spine of sphenoid pierced transversely.
	marginal process to malar. Tapering frontal process to parietal bone.
	with sharp edge. SR. JL. Foramen in tympanic plates. Marginal processes to malars
	tures indistinct.
	t post-coronal depression. Post-sagittal depression. Osseous bridge causing doubling of
	ual.
	ost-coronal depression. Squama low. On R., long ossicle of squamous suture. Triangular
	5 mm. Ossicle of λ and 2 ossicles in posterior sagittal suture. Pterygo-spinous bridge,
	inal process on R.
	e. JR.
	sharp edge. SR. Hamulus lacrimalis reaches orbital margin on R. side. Torus palatinus.
	rp edge. S equal. JR. Nearly complete transverse bridge on foramen in spinous sphenoid.
	JL. Ossicle of pterion R. and L. Slight bathrocephaly, slight torus palatinus.
	Slight post-coronal depression. Mastoidal groove well marked. Pterygo-spinous bridge
	Ossicle of pterion R. and L.
	S equal. JR. Ossicle of pterion and small ossicle in L. coronal suture.
	dge. SR. JL. Torus palatinus. Infra-orbital suture visible on face, R. and L. Perforation
	men 5 mm. across. Outer palate bridge on R.

		Lengths											
No.	Sex	*C*	*F*	*L'*	*L*	*B*	*B'*	*H*	*H'*	*OH*	*LB*	*Q*	*Q'*
204	♀	1127·0	167·5	166·5	166·5	128	92·5	118	117·5	99·5	89	282	284
205	,,	1267·0	179	180·5	180	134·5	91	123	122·5	104·2	90	289	294·5
206	,,	1301·5	185·5	184	185	135·5	95·5	123	122·5	104·7	97	290	293
207	,,	1105·5	166	165	164·5	131·5	87·5	123·5	123	107·5	93	282	283
208	,,	1261·0	177·5	174·5	176·5	131·5	89	120	119	97·5	90·5	273	279
209	,,	1124·5	166	167	167·5	130·5	84	117	117	97·4	92·5	277·5	277
210	,,	—	177	—	174	129·5	85	—	120	—	97	—	—
211	,,	1145·0	171	171·5	170·5	136	97·5	122·5	122	105·5	93	296	300
212	,,	1048·5	159·5	165	163	127	88·5	111·5	110	89·5	91	256	261
213	,,	1124·5	171	173	173	133	87·5	118·5	117·5	106·5	94	273	278
214	,,	—	173	—	175	132	91·5	—	116	—	87·5	—	—
215	,,	1333·5	178	180	180	134·5	93·5	121	119·5	105·3	102	297	298
216	,,	1177·0	163	164	164	128·5	88	131·5	130	110	97·5	300	305·5
217	,,	1294·0	175·5	177	176	133	92·5	126·5	125·5	105·5	97·5	290	293
218	,,	1303·0	180	181	180·5	133·5	95	127·5	127	104·5	97	291	293
219	,,	1062·5	176·5	178·5	178	123·5	85·5	123·5	123	108·3	98	275	274
220	,,	1296·5	187	187	187·5	131	97	127·5	125	103·5	101	289	292·5
221	,,	1255·5	174	174·5	175	134	93	130	128·5	111·3	98	295	297
222	,,	1086·5	168	172	168·5	130	86·5	114·5	113·5	109·5	92·5	278	281
223	,,	1247·0	168	169·5	168·5	138	92·5	126	125·5	104·5	89·5	295	296
224	,,	1253·0	176·5	180	180	133	95	121	120	111	96	289	291
225	,,	1236·5	182·5	181	181·5	138	95	125·5	124·5	105·2	93	298	304
226	,,	1364·0?	180·5	179	179	135	92·5	117?	119?	108	—	302	306
227	,,	1324·5?	184·5	187	187	136	93	123	122·5	108·5	95	295	296
228	♀?	1446·5?	190·5	191	190·5	139·5	95·5	127	127·5	110·3	96·5	305	308·5
229	♀	1147·5	178	183	182	125·5	89	118·5	118	99·4	94·5	270	274
230	,,	1231·5	181·5	183?	183?	130	96·5	116·5	116·5	106	93·5	286	291
231	,,	1277·5	178·5	184	183	133·5	93	124	121	104·5	99·5	288	291
232	,,	1225·0?	169·5	171	170·5	130·5	94·5	126	124·5	105	93·5	286	285
233	,,	1049·5	171	170	170·5	123	87·5	112	111·5	93·3	90·5	260	265
234	,,	1370·0?	181?	183?	184?	131·5	88	121	120·5	101	99	281	284
235	,,	1401·0?	180	—	181	141·5	91	—	126	—	96·5	—	—
236	,,	1174·5	171	173	172	127	99	116·5	115	106·4	93·5	275	280·5
237	,,	—	185	—	189·5	139·5	92·5	—	119	—	94·5	—	—
238	,,	1383·0	180	179·5	179	142	98	123	123	106·4	98·5	307	309
239	,,	1276·0	182	183	183	135	94·5	121	121	104·3	99·5	292	295
240	,,	—	174	180	179	131·5?	88·5	114·5	113	93·5	95	271?	275?
241	,,	1198·5	181·5	181·5	182	135	92	121·5	120·5	100·5	92·5	281	284
242	,,	1220·0	173·5	171·5	172·5	134	92	126	123·5	107	93·5	289	292
243	,,	1319·5	173·5	173	173	141	91	126·5	125	110·5	93	310	314
244	,,	1121·0	173	176·5	176·5	133	89	126	126	104·3	96	289	292
245	,,	1308·0?	182	185	184·5	139·5	95	119	117	109·5	97	305	311
Non-adults													
369	?	1360·0	176	—	175·5	134·5	92	—	119	—	97	—	—
387	?	—	173	—	171·5	126	83·5	—	—	—	—	—	—
388	?	—	—	—	—	135	99·5	—	—	—	—	—	—
389	?	—	—	—	—	—	97	—	—	—	—	—	—

rringdon Street Skulls.

Arcs										Face							
Q	*Q′*	*S*	S_1	S_2	S_3	S_1'	S_2'	S_3'	*U*	*PH*	*G′H*	*GB*	*J*	*NH′*	*NH R*	*NH L*	*NB*
282	284	344	119	114	111	100	100·5	92	476	14·1?	59·2	81·0	113·5	43·3?	43·0	43·9	24·6
289	294·5	366·5	128	118	120·5	110·5	106	93	497	22·2	70·0	86·0	115·5?	48·1	48·0	48·0	22·4
290	293	376·5	132·5	126	118	110·5	113	95·5	519	20·5?	65·7	93·0	118	44·1	48·0	48·0	25·2
282	283	338	117	115	106	99·5	103	89	479·5	—	59·8?	—	—	—	—	—	—
273	279	355·5	121	123·5	111	104	109	91	496	17·8	67·0	85·0	112·5	48·2	47·8	47·1	20·8
277·5	277	335	114	119	102	99	104·5	86·5	476	18·1	59·2	83·2	116	41·0	45·0	44·5	24·6
—	—	350	120	128	102	103·5	111·5	81·5	484·5	16·1	60·5	84·0	—	44·5	45·1	45·1	21·8
296	300	344	110	127	107	98	113·5	87	489	—	—	90·5	123·5?	54·0	52·3	50·9	22·1
256	261	317	102	104	111	92	95·5	93	466·5	—	56·6?	82·1	—	42·6	45·6	45·5	27·0
273	278	344·5	117·5	120	107	103	104	90	488·5	10·2	66·0	89·0	119·5	45·5	45·8	46·1	24·1
—	—	350	125	118	107	107·5	106	87	484	17·3	59·5	89·0	—	42·1	44·5	44·5	24·2
297	298	351	120	119	112	103·5	105·5	94	502·5	16·1	61·8	—	—	45·8	47·9	46·7	25·3
300	305·5	344·5	124·5	114	106	106	99·5	95	469	—	—	86·8	110·5?	—	42·9	—	—
290	293	356	119	127	110	105·5	113·5	93	502	—	—	89·1	121·5	45·0	47·3	48·2	24·0
291	293	361	114	131	116	99·5	116·5	95·5	504	14·8	61·0	88·2	118·5	48·2	46·9	46·0	25·1
275	274	347	118	126	103	104	118·5	84·5	485·5	20·0	65·9	79·8	116	47·6	45·9	47·0	21·2
289	292·5	366	120	132	114	106	116	96	506	19·0?	63·5	88·1	120·5?	44·2?	47·0	47·0	25·4
295	297	350	117	118	115	102	106	94	496	—	—	91·2	122·5?	47·0?	47·0	—	22·4
278	281	342?	120?	115?	107?	99	107	88·5	474?	—	—	82·0	113	46·2	46·6	47·1	23·0
295	296	345	117	116	112	103·5	106·5	94·5	491·5	18·2	63·0	87·5	124·5	45·0	44·9	45·2	22·5
289	291	355	117	122	116	105·5	107	95	503	20·0	67·2	91·5	124	47·1	48·0	48·0	22·8
298	304	372	127	127	118	119	110·5	97	512	—	—	91·0	124	46·9?	50·2	48·8	28·8?
302	306	374	133	130	111	110	114·5	88	511	19·0	63·8	86·5	118·5	44·1	46·1	45·9	24·0
295	296	371	128	121	122	113	109·5	100·5	518?	22·3	70·0	73·5	116·5	47·7	48·0	47·5	25·0
305	308·5	360	139	122	99	117·5	111·5	80	534	15·8	69·1	89·8	119·5	51·5	52·5	51·5	24·2
270	274	355·5	119·5	116	120	117·5	106	98	498	16·1	66·4	—	123·5	50·1	52·9	51·0	25·4
286	291	358·5	117·5	129	112	104	114	93	505	22·0	69·1	—	122	45·1	47·6	47·3	22·3
288	291	363	122	127	114	108·5	109·5	95·5	508	16·1	62·5	90·0	119	46·0	47·9	47·6	23·0
286	285	342	118	114	110	104·5	103·5	95·5	483	15·5	62·2	87·0	116	45·6	44·8	45·2	—
260	265	337	111	115	111	96·5	105·5	90·5	474·5	19·3	65·0	81·1	114	45·4	47·2	46·0	22·2
281	284	—	—	—	114	108·5	108	91	503?	—	—	—	—	50·0	50·8	50·5	—
—	—	365	126	127	112	110·5	113	92	516	20·5	69·5	92·0	—	48·8	48·8	48·8	22·3
275	280·5	340·5	120	100	120·5	105·5	89·5	96·5	485	21·4	72·5	—	—	49·8	53·3	52·1	22·2
—	—	378	133	125	120	117	110	97	522	18·0	67·5	88·9	—	50·1	48·0	48·1	21·6
307	309	362	130·5	121·5	110	110	107·5	93	510·5	12·0	68·2	90·0	122·5	46·0	49·1	48·8	22·8
292	295	356	126	118	112	119	106	90	509	—	—	85·5	117	47·0	50·0	50·0	26·1
271?	275?	342·5	102	132·5	108	92·5	117	93	498	—	—	92·1	122	50·0	52·6	52·6	24·8
281	284	359	120	110	129	106	101·5	99	507	18·0	69·8	87·1	122	51·1	50·5	50·2	23·5
289	292	354	114	130	110	101	112·5	91·5	489	—	—	89·0	121·5	48·0	48·0	48·0	25·0
310	314	359	122	127	110	108	110·5	87·5	498	18·0	62·9	—	119	43·4	43·7	43·2	23·0
289	292	347	128	130	89	114·5	115	80	493	18·2	64·5	84·9	116·5	46·1	46·2	46·8	23·8
305	311	368	128	129	111	113·5	112·5	92	517?	18·6?	67·0	93·8	122·5?	48·8	50·1	48·7	26·1
—	—	348	119	113	116	103·5	98	94·5	499	—	—	—	—	—	—	—	—
—	—	355	120	120	115	101·5	110	92	480	—	—	—	—	—	—	—	—
—	—	—	123	114	—	105·5	102·5	—	—	20·0?	68·2	—	—	47·0	49·8	—	—
—	—	—	120	120	—	107·5	105	—	—	—	62·2	—	—	45·1	45·5	45·5	20·

TABLE OF ABSOLUTE AND INDICIAL MEASUREMENTS OF TH

Nose								Orbits						Palate and Profile						Foramen	
H	*NH*	*NB*	*DS*	*DC*	*DA*	*SS*	*SC*	O_1R	O_1L	O_2R	O_2L	O_1'	*EOW*	G_1	G_1'	G_2	*GL*	*EB*	*EH*	*fml*	*fmb*
·0	43·9	24·6	11·3	21·0	33·8	4·0?	10·4	37·6	38·0	31·6	31·6	36·0	90·5	40·4	39·0	35·8?	83·1	35·5?	8·0?	32·1	26·0
·0	48·0	22·4	10·2	17·0	27·1	2·8	6·5	40·9	41·6	35·0	36·4	39·0	90·2	48·0	46·0	35·2	89·0	35·0	7·3	31·2	23·8
·0	48·0	25·2	13·1	22·1	33·8	3·0	7·0	41·4	41·3	32·3	32·1	39·3	95·0	47·0	44·5	—	93·5	—	—	36·0	28·9
-	—	—	—	—	—	—	—	—	38·6	—	32·8	36·9	—	42·8	41·0	—	82·0	—	—	32·1	26·0
·8	47·1	20·8	7·8	18·0	25·0	2·1	7·0	40·8	40·0	35·5	36·6	39·6	90·1	44·8	42·4	38·0	85·0	38·0	11·2	37·7	29·1
·0	44·5	24·6	9·7	19·5	30·0	1·7	6·3	38·0	39·0	31·0	31·0	36·9	89·1	49·0	45·3	37·0	91·6	37·0	7·8	31·5	28·3
·1	45·1	21·8	9·8	17·1	28·9	2·3	7·5	40·1	39·6	32·0	32·0	39·6	90·3	43·8	41·2	35·8	93·0	36·0	8·2	33·6	27·1
·3	50·9	22·1	13·0	21·1	35·1	5·7	10·2	41·0	41·2	33·2	31·9	39·0	95·0	—	—	—	—	—	—	32·6	26·1
·6	45·5	27·0	12·2	22·3	33·1	5·6	13·3	38·1	38·5	34·1	33·1	37·0	93·3	—	—	37·1	78·0	37·0	6·3	33·7	28·0
·8	46·1	24·1	11·4	19·1	29·2	3·2	8·0	40·0	39·9	35·0	35·6	38·1	92·1	46·5	42·9	—	88·1	—	—	35·4	29·0
·5	44·5	24·2	10·0	21·0	30·1	4·7	10·0	—	39·0	—	33·0	37·6	90·6	39·8	38·9	—	81·1	—	—	33·0	28·0
·9	46·7	25·3	13·6	21·8	36·6	5·1	8·9	42·8	—	32·5	—	41·0	97·5?	—	—	—	102·8	—	—	35·5	30·6
·9	—	—	—	21·9	—	—	—	38·8	—	29·2	—	37·0	91·7	—	—	—	—	—	—	32·0	27·0
·3	48·2	24·0	11·0	19·8	31·8	3·0	8·0	38·7	38·1	34·1	35·0	37·0	90·1	—	—	—	—	—	—	37·5	32·2
·9	46·0	25·1	19·0	23·2	45·0	4·3	8·0	38·2	38·0	30·0	29·5	35·0	92·2	44·3	43·0	—	90·0	—	—	37·5	29·5
·9	47·0	21·2	10·0	19·8	29·0	4·0	9·6	38·0	38·2	33·8	34·0	36·5	88·1	44·9	42·1	31·2	85·0	31·0	4·9	38·9	30·6
·0	47·0	25·4	10·9	23·2	35·5	4·2	13·0	40·0	41·4	32·4	32·0	38·7	96·0	48·2	43·9	37·5	90·5	38·0	10·8	37·1	30·5
·0	—	22·4	12·0	21·0	32·8	—	7·2	39·2	40·0	33·5	33·6	37·0	92·0	47·8	45·0	—	—	—	—	35·1	29·1
·6	47·1	23·0	—	22·0	—	—	—	38·0	38·0	36·8	36·6	34·0	86·8	—	—	—	—	—	—	32·5	25·5
·9	45·2	22·5	11·4	19·5	30·2	2·3	7·0	42·4	43·9	31·9	31·1	41·5	98·5	—	40·2?	38·9	83·8	38·8	8·5	38·0	31·0
·0	48·0	22·8	12·9	21·2	45·2	5·1	9·8	41·0	42·2	34·0	33·5	39·6	98·2	50·5	47·7	39·2	93·8	39·4	9·5	32·8	29·0
·2	48·8	28·8?	9·6	22·2	30·5	3·5	9·1	42·6	42·0	33·0	35·0	40·9	99·8	—	—	—	—	—	—	36·7	29·9
·1	45·9	24·0	12·2	23·8	37·5	4·5	8·1	40·0	40·0	34·0	32·9	37·9	95·0	45·9	43·2	—	—	—	—	—	28·1
·0	47·5	25·0	12·3	21·1	33·5	4·3	9·1	39·2	40·0	32·5	31·1	36·0	93·0	50·0	47·5	—	95·6	—	—	34·2	29·6
·5	51·5	24·2	9·5	20·8	28·8	2·0	5·9	41·0	42·8	37·0	35·0	40·1	97·7	49·9	47·2	—	90·8	—	—	—	—
·9	51·0	25·4	11·8	23·0	33·0	5·6	10·9	—	40·0	—	35·4	37·2	—	48·0	44·9	—	88·4	—	—	32·8	25·5
·6	47·3	22·3?	10·2	23·0	33·0	2·0	8·0	43·5	—	35·6	—	41·8	98·5	50·1	47·8	—	93·9	—	—	37·0	27·2
·9	47·6	23·0	13·7	21·5	37·9	4·9	11·0	42·2	42·8	33·0	31·8	40·0	95·0	48·8	44·7	39·0	91·0	39·0	9·8	34·1	28·0
·8	45·2	—	9·0	20·8	28·8	2·1	8·8	41·5	41·8	35·0	33·8	39·8	95·0	46·9	41·9	35·0	85·5	35·0	7·7	33·6	28·9
·2	46·0	22·2	9·9	21·2	30·3	5·3	12·3	39·1	40·0	32·0	31·8	37·2	82·8	49·1	46·2	39·1?	88·0	39·0?	5·1	32·7	29·6
·8	50·5	—	—	—	—	—	—	42·0	—	39·5	—	40·1	—	—	—	—	—	—	—	35·2	27·8
·8	48·8	22·3	11·6	19·5	28·9	4·3	7·4	38·9	39·9	33·0	32·0	37·4	91·9	49·5	47·1	36·0	95·3	36·0	11·8	32·0	28·8
·3	52·1	22·2	11·6	23·9	32·0	4·2	9·4	—	42·4	—	36·0	39·2	96·0?	44·2?	44·0	35·7	82·8	36·0	14·8	36·0	30·2
·8	48·1	21·6	11·4	20·0	31·8	4·9	8·3	39·0	39·0	32·0	30·8	36·9	90·5	45·8	43·0	39·0	91·1	39·0	13·1	33·7	31·0
·1	48·8	22·8	12·1	23·1	32·5	4·7	11·4	40·2	40·8	35·0	34·8	39·0	98·0	48·0	46·2	39·8	91·6	39·8	11·0	29·2	29·0
·0	50·0	26·1	—	21·4	33·2?	—	8·8	41·9	40·6	32·9	32·9	39·6	93·0	—	—	—	—	—	—	35·0	26·6
·6	52·6	24·8	11·8	21·2	33·7	5·5	10·0	41·0	41·1	38·3	36·6	38·3	94·0	—	—	—	—	—	—	37·0	29·5
·5	50·2	23·5	10·9	21·0	31·2	3·1	8·6	41·9	42·2	37·9	35·6	40·0	95·1	50·0	46·9	39·0	89·1	39·0	8·5	34·5	29·9
·0	48·0	25·0	12·3?	18·0	33·5?	4·0	7·9	42·0	44·0	33·5	32·5	39·4	95·0	—	—	—	—	—	—	32·5	27·4
·7	43·2	23·0	15·2	24·0	43·0	2·8	10·0	38·5	—	34·0	—	36·0	93·0?	46·2	43·0	40·1	91·1	40·0	12·0	31·0	26·0
·2	46·8	23·8?	10·1	21·0	30·0	4·6	10·0	39·5	38·0	32·0	30·5	35·5	90·0	46·5	42·8	35·5	93·0	35·5	13·1	35·0	28·8
·1	48·7	26·1	13·8?	23·9	37·2?	4·5	11·8	43·2	43·0	34·2	33·9	41·1	99·8	55·0	51·1	—	99·1	—	—	33·1	26·1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	36·0	31·3
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24·3
49·8	—	—	—	—	—	—	—	39·2	—	34·2	—	36·0	—	—	44·0?	—	—	—	—	—	—
45·5	45·5	20·3	11·3	19·0?	32·0	4·4	10·0	40·1	39·2	33·8	34·1	37·9	93·0	40·9	39·5	—	—	—	—	—	—

REMENTS OF THE INDIVIDUAL CRANIA. (Lengths in Millimetres.)

le		Foramen		Indices													
EB	*EH*	*fml*	*fmb*	*Oc.I.*	*B/L'*	*H/L'*	*B/L*	*H/L*	*B/H*	*H'/L*	*B/H'*	$\frac{B-H'}{L}$	*G'H/GB*	$\frac{NB}{NH}$ *R*	$\frac{NB}{NH}$ *L*	$\frac{O_2}{O_1}$ *R*	O_2
35·5?	8·0?	32·1	26·0	59·5	76·9	70·9	76·9	70·9	108·5	70·6	108·9	6·3	73·1	57·2	56·0	84·0	8
35·0	7·3	31·2	23·8	55·4	74·5	68·2	74·7	68·3	109·3	68·1	109·8	6·6	81·4	46·7	46·7	85·6	8
—	—	36·0	28·9	57·7	73·6	66·8	73·2	66·5	110·2	66·2	110·6	7·0	70·6	52·5	52·5	78·0	7
—	—	32·1	26·0	60·7	79·7	74·9	79·9	75·1	106·5	74·8	106·9	5·1	—	—	—	—	8
38·0	11·2	37·7	29·1	58·6	75·4	68·8	74·5	68·0	109·6	67·4	110·5	7·1	78·8	43·5	44·2	87·0	9
37·0	7·8	31·5	28·3	61·8	78·1	70·1	77·9	69·9	111·5	69·9	111·5	8·0	71·2	54·7	55·3	81·6	7
36·0	8·2	33·6	27·1	57·0	—	—	74·4	—	—	69·0	107·9	5·4	72·0	48·3	48·3	79·8	8
—	—	32·6	26·1	58·1	79·3	71·4	79·8	71·8	111·0	71·6	111·5	8·2	—	42·3	43·4	81·0	7
37·0	6·3	33·7	28·0	60·5	77·0	67·6	77·9	68·4	113·9	67·5	115·5	10·4	68·9	59·2	59·3	89·5	8
—	—	35·4	29·0	60·9	76·9	68·5	76·9	68·5	112·2	67·9	113·2	9·0	74·2	52·6	52·3	87·5	8
—	—	33·0	28·0	58·1	—	—	75·4	—	—	66·3	113·8	9·1	66·9	54·4	54·4	—	8
—	—	35·5	30·6	60·7	74·7	67·2	74·7	67·2	111·2	66·4	112·6	8·3	—	52·8	54·2	75·9	
—	—	32·0	27·0	70·7	78·4	80·2	78·4	80·2	97·7	79·3	98·8	−0·9	—	—	—	75·3	
—	—	37·5	32·2	61·4	75·1	71·5	75·6	71·9	105·1	71·3	106·0	4·3	—	50·7	49·8	88·1	9
—	—	37·5	29·5	59·0	73·8	70·4	74·0	70·6	104·8	70·4	105·1	3·6	69·2	53·5	54·6	78·5	7
31·0	4·9	38·9	30·6	58·7	69·2	69·2	69·4	69·4	100·0	69·1	100·4	0·3	82·6	46·2	45·1	88·9	8
38·0	10·8	37·1	30·5	61·0	70·1	68·2	69·9	68·0	102·7	66·7	104·8	3·2	72·1	54·0	54·0	81·0	7
—	—	35·1	29·1	58·5	76·8	74·5	76·6	74·3	103·1	73·4	104·3	3·2	—	47·7	—	85·5	8
—	—	32·5	25·5	59·4	75·6	66·6	77·2	68·0	113·5	67·4	114·5	9·8	—	49·4	48·8	96·8	9
38·8	8·5	38·0	31·0	61·2	81·4	74·3	81·9	74·8	109·5	74·5	110·0	7·4	72·0	50·1	49·8	75·2	7
39·4	9·5	32·8	29·0	58·6	73·9	67·3	73·9	67·2	109·9	66·7	110·8	7·2	73·4	47·5	47·5	82·9	7
—	—	36·7	29·9	58·9	76·2	69·2	76·0	69·1	110·0	68·6	110·8	7·4	—	57·4	59·0	77·5	8
—	—	—	28·1	56·6	75·4	65·4	75·4	65·4	115·4	66·5	113·4	8·9	73·7	52·1	52·3	85·0	8
—	—	34·2	29·6	59·0	72·7	65·8	72·7	65·8	110·5	65·5	110·0	7·2	95·2	52·1	52·6	82·9	7
—	—	—	—	57·7	73·0	66·6	73·2	66·7	109·8	66·9	109·4	6·3	76·9	46·1	47·0	90·2	8
—	—	32·8	25·5	58·4	68·6	64·8	69·0	65·1	105·9	64·8	106·4	4·2	—	48·0	49·8	—	8
—	—	37·0	27·2	59·7	71·0	63·7	71·0	63·7	111·6	63·7	111·6	7·3	—	46·8	47·1	81·8	
39·0	9·8	34·1	28·0	60·5	72·6	67·4	73·0	67·8	107·7	66·1	110·3	6·9	69·4	48·0	48·3	78·2	7
35·0	7·7	33·6	28·9	64·7	76·3	73·7	76·5	73·9	103·6	73·0	104·8	3·5	71·5	—	—	84·3	8
39·0?	5·1	32·7	29·6	58·2	72·4	65·9	72·1	65·7	109·8	65·4	110·3	6·7	80·1	47·0	48·3	81·8	7
—	—	35·2	27·8	56·9	71·9	66·1	71·5	65·8	108·7	66·5	109·1	5·0	—	—	—	94·0	
36·0	11·8	32·0	28·8	58·8	—	—	78·2	—	—	69·6	112·3	8·6	75·5	45·7	45·7	84·8	8
36·0	14·8	36·0	30·2	57·1	73·4	67·3	73·8	67·7	109·0	66·9	110·4	6·9	—	41·7	42·6	—	8
39·0	13·1	33·7	31·0	57·7	—	—	73·6	—	—	62·8	117·2	10·8	75·9	45·0	44·9	82·1	7
39·8	11·0	29·2	29·0	61·4	79·1	68·5	79·3	68·7	115·4	68·7	115·4	10·6	75·8	46·4	46·7	87·1	8
—	—	35·0	26·6	57·3	73·8	66·1	73·8	66·1	111·6	66·1	111·6	7·7	—	52·2	52·2	78·5	8
—	—	37·0	29·5	63·6	73·1	63·6	73·5	64·0	114·8	63·1	116·4	10·4	—	47·1	47·1	93·4	8
39·0	8·5	34·5	29·9	55·2	74·4	66·9	74·2	66·8	111·1	66·2	112·0	8·0	80·1	46·5	46·8	90·5	8
—	—	32·5	27·4	59·9	78·1	73·5	77·7	73·0	106·3	71·6	108·5	6·1	—	52·1	52·1	79·8	7
40·0	12·0	31·0	26·0	56·8	81·5	73·1	81·5	73·1	111·5	72·3	112·8	9·2	—	52·6	53·2	88·3	
35·5	13·1	35·0	28·8	71·4	75·4	71·4	75·4	71·4	105·6	71·4	105·6	4·0	76·0	51·5	50·9	81·0	8
—	—	33·1	26·1	59·5	75·4	64·3	75·6	64·5	117·2	63·4	119·2	12·2	71·4	52·1	53·6	79·2	7
—	—	36·0	31·3	58·2	—	—	76·6	67·8	—	—	113·0	8·8	—	—	—	—	
—	—	—	24·3	57·1	—	—	73·5	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	87·2	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	44·6	44·6	80·2	

									Angles (in degrees)						
B/NH L	O_2/O_1 R	O_2/O_1 L	O_2/O_1'	G_2/G_1	EH/EB	fmb/fml	DS/DC	SS/SC	$N\angle$	$A\angle$	$B\angle$	θ_1	θ_2	$P\angle$	
56·0	84·0	83·2	87·8	88·6	22·5	81·0	53·8	38·5	64·5	75·5	40·0	29·9	10·1	85·6	Cal. P.B. flat with rounded edge λ projecting into R. parietal
46·7	85·6	87·5	89·7	73·3	20·9	76·3	60·0	43·1	66·0	68·0	46·0	30·4	15·6	83·6	Cal. P.B. flat with sharp edge. S mastoid and temporal squam
52·5	78·0	77·7	82·2	—	—	80·3	59·3	42·9	66·8	73·0	40·2	28·2	12·0	85·0	Cal. P.B. upwards with rounded Post-coronal depression.
—	—	85·0	—	—	—	81·0	—	—	60·2	80·6	39·2	—	—	—	Cal. – part f. S equal. JR.
44·2	87·0	91·5	89·6	84·8	29·5	77·2	43·3	30·0	63·0	72·1	44·9	34·2	10·7	82·8	Cal. 4-cusped 2nd molar on R.
55·3	81·6	79·5	84·0	75·5	21·1	89·8	49·7	27·0	70·4	72·0	37·6	30·6	7·0	79·0	Cal. Good teeth. P.B. upwards
48·3	79·8	80·8	80·8	81·7	22·8	80·7	57·3	30·7	66·8	76·4	36·8	—	—	—	Cal. br. 3 carious teeth. P.B. u median plane.
43·4	81·0	77·4	85·1	—	—	80·1	61·6	55·9	—	—	—	—	—	—	Cal. Edentulous. P.B. flat with Posterior interparietal bone.
59·3	89·5	86·0	92·2	—	17·0	83·1	54·7	42·1	58·0	84·0	38·0	—	—	—	Cal. Teeth good. 4-cusped 2nd
52·3	87·5	89·2	91·9	—	—	81·9	59·7	40·0	63·9	74·0	42·1	32·5	9·6	83·6	Cal. P.B. rounded. S equal. JL
54·4	—	84·6	—	—	—	84·8	47·6	47·0	63·6	75·3	41·1	—	—	—	Cal. br. P.B. upwards with shar L. malar marginal process we
54·2	75·9	—	79·3	—	—	86·2	62·4	57·3	73·0	72·0	35·0	23·4	11·6	83·6	Cal. – part f. Good teeth. P.B.
—	75·3	—	78·9	—	—	84·4	—	—	—	—	—	—	—	—	Cal. – part f. S equal. JL. Syl
49·8	88·1	91·9	92·2	—	—	85·9	55·6	37·5	—	—	—	—	—	84·9	Cal. Edentulous. P.B. upwards
54·6	78·5	77·6	85·7	—	—	78·7	81·9	53·8	64·9	77·2	37·9	29·4	8·5	85·7	Cal. P.B. downwards with shar appreciable deviation. Infra-
45·1	88·9	89·0	92·6	69·7	15·8	78·7	50·5	41·7	58·5	80·2	41·3	34·3	7·0	87·2	Cal. P.B. flat with sharp edge. SI spinous bridge and foramen o
54·0	81·0	77·3	83·7	77·8	28·4	82·2	46·6	32·3	61·8	80·0	38·2	31·2	7·0	87·0	Cal. Teeth good. P.B. upwards
—	85·5	84·0	90·5	—	—	82·9	57·1	—	—	—	—	—	—	—	Cal. P.B. flat with rounded edg occipital prominence.
48·8	96·8	96·3	92·4	—	—	78·5	—	—	—	—	—	—	—	—	Cal. Diseased. P.B. upwards wit in R. temporal squama.
49·8	75·2	70·8	76·9	—	21·9	81·6	58·5	32·9	63·5	74·0	42·5	30·7	11·8	85·8	Cal. P.B. upwards with sharp ed
47·5	82·9	79·4	85·9	77·6	24·1	88·4	60·8	52·0	73·5	66·2	40·3	23·1	17·2	83·4	Cal. Teeth good. P.B. flat with r
59·0	77·5	83·3	80·7	—	—	81·5	43·2	38·5	—	—	—	—	—	—	Cal. Edentulous. P.B. upwards obelion.
52·3	85·0	82·3	89·7	—	—	—	51·3	55·6	—	—	—	—	—	87·9	Cal. br. P.B. upwards with shar
52·6	82·9	77·8	90·3	—	—	86·5	58·3	47·3	68·8	68·1	43·1	27·6	15·5	83·6	Cal. br. P.B. rounded. SL. JR.
47·0	90·2	81·8	92·3	—	—	—	45·7	33·9	63·9	73·0	43·1	28·3	14·8	87·8	Cal. br. P.B. upwards with sharp of obelion.
49·8	—	88·5	—	—	—	77·7	51·3	51·4	63·6	73·9	42·5	31·2	11·3	85·2	Cal. br. P.B. upwards with shar
47·1	81·8	—	85·2	—	—	73·5	44·3	25·0	68·4	68·1	43·5	27·7	15·8	83·9	Cal. – part f. P.B. upwards wit
48·3	78·2	74·3	82·5	79·9	25·1	82·1	63·7	44·5	63·5	78·6	37·9	29·4	8·5	87·1	Cal. Teeth good. P.B. upwards
—	84·3	80·9	87·9	74·6	22·0	86·0	43·3	23·9	62·7	76·9	40·4	31·8	8·6	85·5	Cal. br. 4-cusped 2nd molar. P.
48·3	81·8	79·5	86·0	79·6	13·1	90·5	46·7	43·1	66·6	70·8	42·6	32·2	11·4	81·2	Cal. P.B. upwards with sharp ed
—	94·0	—	98·5	—	—	79·0	—	—	—	—	—	—	—	—	Cal. br. Edentulous. P.B. upwa
45·7	84·8	80·2	88·2	72·7	32·8	90·0	59·5	58·1	67·8	69·8	42·4	—	—	—	Cal. br. Teeth good. 4-cusped 2
42·6	—	84·9	—	80·8	41·1	83·9	48·5	44·7	57·9	73·9	48·2	34·1	14·1	88·0	Cal. – part f. 4-cusped 2nd and 5 mm. Ossicle of λ. Ossicle o
44·9	82·1	79·0	86·7	85·2	33·6	92·0	57·0	59·0	66·0	71·2	42·8	—	—	—	Cal. br. 1 carious tooth. P.B. up
46·7	87·1	85·3	89·7	82·9	27·6	99·3	52·4	41·2	63·4	74·7	41·9	29·1	12·8	87·5	Cal. 1 carious tooth. P.B. upwa
52·2	78·5	81·0	83·1	—	—	76·0	—	—	—	—	—	—	—	85·6	Cal. Edentulous. P.B. upwards
47·1	93·4	89·1	100·0	—	—	79·7	55·7	55·0	—	—	—	—	—	—	Cal. br. Edentulous. P.B. upwa
46·8	90·5	84·4	94·7	78·0	21·8	86·7	51·9	36·0	64·9	70·1	45·0	33·6	11·4	81·5	Cal. P.B. upwards with sharp ed
52·1	79·8	73·9	85·0	—	—	84·3	68·3	50·6	—	—	—	—	—	—	Cal. Edentulous except for retai
53·2	88·3	—	94·4	86·8	30·0	83·9	63·3	28·0	68·4	71·7	39·9	27·5	12·4	84·1	Cal. Teeth good. L. canine dela
50·9	81·0	80·3	90·1	76·3	36·9	82·3	48·1	46·0	67·2	72·9	39·9	28·6	11·3	84·2	Cal. 2 carious teeth. P.B. upwa
53·6	79·2	78·8	83·2	—	—	78·9	57·7	38·1	71·5	68·6	39·9	23·7	16·2	84·8	Cal. br. P.B. upwards with blun
—	—	—	—	—	—	86·9	—	—	—	—	—	—	—	—	Cal. 18–20 years. 4-cusped 2nd
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Cal. – f. 4–5 years. SR. JL. T
—	87·2	—	95·0	—	—	—	—	—	—	—	—	—	—	—	Cal. br. – part f. P.B. upwards w of λ. Ossicle in middle of R.
44·6	80·2	87·0	89·2	—	—	—	59·5	44·0	—	—	—	—	—	—	Cal. br. – part f. P.B. upwards

Angles (in degrees)

$A\angle$	$B\angle$	θ_1	θ_2	$P\angle$	Remarks
75·5	40·0	29·9	10·1	85·6	Cal. P.B. flat with rounded edge. SR. JL. Metopic suture. RF + LP 4 mm. Slight post-coronal depression. λ projecting into R. parietal 20 × 14 mm.
68·0	46·0	30·4	15·6	83·6	Cal. P.B. flat with sharp edge. S equal. JL. Linguiform process to occipital bone. R. infra-orbital facial suture mastoid and temporal squama very distinct.
73·0	40·2	28·2	12·0	85·0	Cal. P.B. upwards with rounded edge. SR. J equal. Ossicle in squamous suture. On L. pterygoid plate small Post-coronal depression.
80·6	39·2	—	—	—	Cal. – part f. S equal. JR.
72·1	44·9	34·2	10·7	82·8	Cal. 4-cusped 2nd molar on R. P.B. flat with blunt edge. SR. J equal.
72·0	37·6	30·6	7·0	79·0	Cal. Good teeth. P.B. upwards with sharp edge. S equal. JR. Small ossicle of pterion on R.
76·4	36·8	—	—	—	Cal. br. 3 carious teeth. P.B. upwards with sharp edge. SR. Bathrocephaly. R. tympanic perforation. Prec median plane.
—	—	—	—	—	Cal. Edentulous. P.B. flat with sharp edge, double on R. S equal. JR. Metopic suture. RF + LP 3 mm. Spher Posterior interparietal bone. Insular ossicle on mastoid, R. and L.
84·0	38·0	—	—	—	Cal. Teeth good. 4-cusped 2nd molars. P.B. upwards with blunt edge. SR. JR. Pterions in K. Depression o
74·0	42·1	32·5	9·6	83·6	Cal. P.B. rounded. S equal. JL. Infra-orbital sutures visible on face.
75·3	41·1	—	—	—	Cal. br. P.B. upwards with sharp edge. SR. 2 processes on R. pterygoid plate as in 1. Small frontal process L. malar marginal process well developed.
72·0	35·0	23·4	11·6	83·6	Cal. – part f. Good teeth. P.B. flat with sharp edge. SR. JL. R. pterygo-spinous bridge and foramen.
—	—	—	—	—	Cal. – part f. S equal. JL. Sylvian groove marked.
—	—	—	—	84·9	Cal. Edentulous. P.B. upwards with sharp edge. SR. J equal. L. parieto-frontal overlap. Inion distinct.
77·2	37·9	29·4	8·5	85·7	Cal. P.B. downwards with sharp edge. S equal. JL. Retained tooth (? canine) behind lateral incisor R. and appreciable deviation. Infra-orbital facial sutures distinct. R. and L.
80·2	41·3	34·3	7·0	87·2	Cal. P.B. flat with sharp edge. SR. J equal. Post-coronal depression. Small ossicle of λ. Sutura notha. Ossicle of spinous bridge and foramen on R.
80·0	38·2	31·2	7·0	87·0	Cal. Teeth good. P.B. upwards with sharp edge. SL. JL. Mastoidal sulcus marked. Parieto-frontal overlap.
—	—	—	—	—	Cal. P.B. flat with rounded edge. SL. Traces of metopic suture. Sutures almost obliterated. Plagiocephaly R occipital prominence.
—	—	—	—	—	Cal. Diseased. P.B. upwards with blunt edge. S equal. J equal. Nearly edentulous. Remaining 2nd molar 4-cu in R. temporal squama.
74·0	42·5	30·7	11·8	85·8	Cal. P.B. upwards with sharp edge. SR. JL. Ossicle of lambdoid suture 20 × 14 mm. Tympanic foramen on R
66·2	40·3	23·1	17·2	83·4	Cal. Teeth good. P.B. flat with rounded edge. SR. JR. Infra-orbital suture visible on face R. and L. Traces of oss
—	—	—	—	—	Cal. Edentulous. P.B. upwards with sharp edge. SR. JL. Broad malars. Inner palate bridge nearly complete obelion.
—	—	—	—	87·9	Cal. br. P.B. upwards with sharp edge. SR.
68·1	43·1	27·6	15·5	83·6	Cal. br. P.B. rounded. SL. JR. Slight bathrocephaly. Tapering process to L. parietal bone.
73·0	43·1	28·3	14·8	87·8	Cal. br. P.B. upwards with sharp edge. SL. JR. Ossicle of L. squamous suture. Small process on L. pterygoid of obelion.
73·9	42·5	31·2	11·3	85·2	Cal. br. P.B. upwards with sharp edge. SR. JR.
68·1	43·5	27·7	15·8	83·9	Cal. – part f. P.B. upwards with rounded edge. S equal. JR. Metopic. No appreciable deviation. Slight bat
78·6	37·9	29·4	8·5	87·1	Cal. Teeth good. P.B. upwards with sharp edge. SR. JR. Post-coronal depression. Spheno-parietal suture 5
76·9	40·4	31·8	8·6	85·5	Cal. br. 4-cusped 2nd molar. P.B. upwards with sharp edge. SR. J equal. Cribriform tympanic plate.
70·8	42·6	32·2	11·4	81·2	Cal. P.B. upwards with sharp edge. S equal. JL. Tympanic foramen R. and L. Slight bathrocephaly.
—	—	—	—	—	Cal. br. Edentulous. P.B. upwards with sharp edge. S equal. J equal.
69·8	42·4	—	—	—	Cal. br. Teeth good. 4-cusped 2nd molar. P.B. upwards with sharp edge.
73·9	48·2	34·1	14·1	88·0	Cal. – part f. 4-cusped 2nd and 3rd molars. P.B. upwards with rounded edge. SR. JR. Vestiges of metopic 5 mm. Ossicle of λ. Ossicle of pterion on R.
71·2	42·8	—	—	—	Cal. br. 1 carious tooth. P.B. upwards with sharp edge.
74·7	41·9	29·1	12·8	87·5	Cal. 1 carious tooth. P.B. upwards with blunt edge. S equal. JR.
—	—	—	—	85·6	Cal. Edentulous. P.B. upwards with double edge. S equal. JR. Infra-orbital facial suture distinct R. and L.
—	—	—	—	—	Cal. br. Edentulous. P.B. upwards with sharp edge. S equal. JR. Sutures almost obliterated.
70·1	45·0	33·6	11·4	81·5	Cal. P.B. upwards with sharp edge. S equal. JR. Slight bathrocephaly.
—	—	—	—	—	Cal. Edentulous except for retained L. canine. P.B. upwards with blunt edge. SR. JR.
71·7	39·9	27·5	12·4	84·1	Cal. Teeth good. L. canine delayed and behind lateral incisor. P.B. flat with rounded edge. SR. JR. Small
72·9	39·9	28·6	11·3	84·2	Cal. 2 carious teeth. P.B. upwards with sharp edge. SR. J equal. Ossicle of λ 28 × 32 mm.
68·6	39·9	23·7	16·2	84·8	Cal. br. P.B. upwards with blunt edge. SR. JR.
—	—	—	—	—	Cal. 18–20 years. 4-cusped 2nd molars. 3rd molars coming down. SR. JR. P.B. upwards with sharp edge.
—	—	—	—	—	Cal. – f. 4–5 years. SR. JL. Tympanic foramen not qaite closed. Post-coronal depression. Basi-occipital no
—	—	—	—	—	Cal. br. – part f. P.B. upwards with sharp edge. Metopic suture. LF + RP 6 mm. Pterygo-spinous bridge and fo of λ. Ossicle in middle of R. coronal suture 9 × 10 mm.
—	—	—	—	—	Cal. br. – part f. P.B. upwards with sharp edge. 4-cusped 2nd molar. Infra-orbital facial suture distinct on

nal depression. Pterions in K. Ossicle of
ital facial suture distinct. Suture between
rgoid plate small process as in skull No. 1.

perforation. Precondylar nodule to L. of
LP 3 mm. Spheno-parietal suture 6 mm.
K. Depression of obelion.
ll frontal process on L. temporal squama.
d foramen.
ion distinct.
al incisor R. and L. Metopic suture. No
notha. Ossicle of pterion on L. Pterygo-
-frontal overlap.
Plagiocephaly R. frontal and L. parieto-
ng 2nd molar 4-cusped. Styliform process
nic foramen on R.
d L. Traces of ossicles of lambdoid suture.
nearly complete L. and R. Flattening of

on L. pterygoid plate as in 1. Flattening

ation. Slight bathrocephaly.
parietal suture 5 mm.
anic plate.
ocephaly.

estiges of metopic suture. LF + RP about

istinct R. and L.
d.

SR. JR. Small epipterics R. and L.

vith sharp edge. Post-coronal depression.
Basi-occipital not yet united.
nous bridge and foramen R. and L. Ossicle

ture distinct on R.

		Lengths							Arcs				
No.	Sex	*C*	*F*	*L*	*B*	*B′*	*H′*	*LB*	*S*	S_1	S_2	S_3	S_1'
100	♂	1530·5	183	190	156·5	106	127	102	392	148	133	111	120
101	,,	1680·5	194	197·5	147	98·5	139·5	105	398	134	134	130	114·5
102	,,	—	195·5	198	145·5	99·5	131	99·5	411	134·5	147	129·5	114
103	,,	1516·5	199·5	202	146	94·5	125	105	402	141	131	130	119·5
104	,,	1703·5?	200	204	153·5	95·5	135	100·5	416	145	138	133	128
105	,,	—	191	196	146·5	95	129	98·5	387·5	132	134	121·5	114·5
106	,,	1670·5	190·5	192·5	148	102	139·5	105·5	391	125	136	130	119·5
107	,,	—	182	187	142·5	90	—	—	376	128	134·5	113·5	113
108	,,	1483·5	193	195·5	144·5	99	124·5	97·5	388	130	140	118	114
109	,,	1755·5?	195·5	198·5	153	105	131	97	413	142	161	110	121
110	,,	1609·5	193	194	144	106·5	—	93·5?	411	—	—	138	—
111	,,	1575?	188·5	191·5	141·5	96·5	136	99	392	134	137	121	115
112	,,	—	187	193·5	143·5	97	127·5	102	380	126·5	122·5	131	111
113	,,	—	195	198·5	140·5	100	130·5	107·5	388	139	129	120	121
114	,,	—	178·5	180·5	146·5	100	—	—	—	131	126	—	115
115	,,	—	173	176·5	137·5	93	—	—	360	121	123	116	104
116	,,	—	200·5	200·5	148·5	107	130·5	104	396	142	143	111	119·5
117	,,	—	186·5?	192·5?	129·5	93·5	128	102	375?	126??	100??	149??	111·5
118	,,	1415	180	183	142	91	128·5	94	373	135	120	118	117
119	,,	1486	186·5	185	143	97	126	94	384	129	127	128	112
120	,,	1426	185	190·5	140·5	102	127·5?	99·5	380	126	128	126	110·5
121	,,	—	193·5	196·5	157	96·5	126	97·5	369	130	137	102	113
122	,,	1512·5	184	187·5	140·5	98·5	129	103·5	383	127	135	121	112
123	,,	1582·5?	192·5	197	139	99·5	132	103·5	392	133·5	141	117·5	116
124	,,	—	183·5	184·5	137	85·5	120?	87	366	132	116	118	116
125	,,	—	184·5	189	132	88·5	129	104	365	124	123	118	111·5
126	,,	—	200·5	200	142·5?	104	138?	109?	390	130·5	130	130	113
127	,,	—	181	182	153·5	95	—	—	360	122	120	118	110?
128	,,	—	184	186·5	146	101	—	—	—	131	143	—	115
129	,,	—	191??	—	142·5	—	—	—	—	—	130	133	—
130	,,	—	178·5	182	146	100	—	—	—	132	130	—	116·5
131	♂?	—	186·5	189	138·5?	98·5	—	—	—	126	128	—	108
132	♂	—	185	190·5	138·5	94	—	—	370	118	129	123	105·5
133	,,	—	200	205	147·5	—	128	106·5	398	132	130	136	117
134	,,	—	189·5	192	147	103	—	—	390	136	134	120	119·5
135	,,	—	190	192	147	100·5	—	—	375	123	129	123	107·5
136	,,	—	197·5	202	130·5	97	125·5	109·5	—	140	118	—	122·5
137	,,	—	187	189·5	136·5	93·5	—	—	373?	140	120	113?	117·5
138	,,	—	191·5	192	150·5	101	137	97·5	403	138	143	122	115
139	,,	1446·5?	181	189	132·5	97·5	130	103·5	370	125	130	115	110·5
141	,,	1327	187	188·5	140·5	96·5	119·5	92·5	377	118	134	125	101
142	,,	—	185	188·5	143·5	96	130	97·5	374	134	131	109	119·5
143	♂?	—	190	190·5	141·5	93	137·5	106	381	128	133	120	111·5
144	♂	—	188	189·5	143·5	99	—	—	379	129	132	118	114
145	♂?	—	180·5	182·5	138	95·5	126·5	90	374	120	139	115	107
246	,,	—	185	187	—	98	—	—	374?	128?	143	103	113?
247	♂	1399·5	188·5	186	135·5	94·5	136·5	101	378	133	121	124	116
251	♂?	1342?	184	183	135·5	96·5	122·5	101	361	123	126	112	107
253	♂	1586·5	186	189	152	94·5	136	98·5	385	136	126	123	119·5
257	♂?	—	—	—	152	—	129·5	—	—	—	133·5	118	—
289	♂	1221·5	174·5	176	131·5	95	129·5	99	357	126	114	117	108
290	,,	1337	170·5	176	145	95	121·5	102	348	113	122	113	103·5
292	♂?	1376·5	180·5	182	139	97	133	93	383	130	138	115	114·5
295	♂	—	177	180·5	140	—	134	95	376	126	125	125	111
296	♂?	1446·5	180·5	181	145	99	119	97	361	126	129	106	108·5
299	♂	—	189	190·5	144·5	89·5	128·5	99·5	385	131	124	130	116
372	,,	1207·5	176·5	177	132	90	119	94·5	349	127	112	110	108·5
373	♂?	—	184·5	184·5	139	—	—	—	—	130	123	—	111
374	♂	—	—	—	—	98	—	—	—	140	—	—	123·5
375	,,	—	—	—	145·5?	—	—	—	—	—	129	120	—
376	,,	—	180·5	184	135·5	94·5	—	—	—	—	130	—	—
377	,,	—	189·5	190·5	—	102?	—	—	366	129	116	121	109·5
378	,,	—	—	—	—	91	—	—	—	124	—	—	110·5
379	,,	—	—	—	—	100	—	—	—	122	—	—	105·5
380	♂?	—	—	—	142	—	—	—	—	—	130	118	—
381	,,	—	—	—	—	—	—	—	—	—	123	119	—
382	,,	—	—	—	138·5	93·5	—	—	—	127	—	—	113
383	,,	—	181·5	183·5	—	94	—	—	—	119	116	122	104
384	,,	—	187·5	190·5	141	—	—	—	368	122	127	119	107·5?
385	,,	—	—	—	—	93	—	—	—	—	128	117	—
386	,,	—	173·5	178	—	93·5	—	—	—	129	132	—	107·5

Arcs					Foramen		Indices						
S_3	S_1'	S_2'	S_3'	U	*fml*	*fmb*	*Oc.I.*	*B/L*	*H'/L*	*B/H'*	$\frac{B-H}{L}$	*fmb/fml*	
111	120	114	89	547	37·0	30·0	57·2	82·4	66·8	123·2	15·6	81·1	Cal. – f. SR. J equal. Well develope
130	114·5	122	104·5	550	37·6	32·3	57·3	74·4	70·6	105·4	3·8	85·9	Cal. – f. J equal. Inion strong. Long
129·5	114	127	101	547?	31·0	24·9	55·8	73·5	66·2	111·1	7·3	80·3	Br. cal. – f. JR. Median occipital tor
130	119·5	117·5	98	557	32·1	29·9	54·6	72·3	61·9	116·8	10·4	93·1	Br. cal. – f. S equal. J equal. Faint
133	128	113	113	565	37·0	27·1	62·0	75·2	66·2	113·7	9·0	73·2	Cal. – f. S equal. JL. Median occipit
121·5	114·5	120	97·5	542	37·0	30·0	57·2	74·7	65·8	113·6	8·9	81·1	Br. cal. – f. S equal. JL.
130	119·5	120·5	107·5	545·5	37·2	31·0	59·4	76·9	72·5	106·1	4·4	83·3	Cal. – f. SR. JR. Metopic suture ab
113·5	113	118·5	92	518	—	—	57·8	76·2	—	—	—	—	Br. cal. – f. SR. Strong inion.
118	114	112·5	96·5	548?	37·1	32·0	58·5	73·9	63·7	116·1	10·2	86·3	Br. cal. – f. SR. JR. Bathrocephaly.
110	121	142	96·5	557	33·6	29·0	66·4	77·1	66·0	116·8	11·1	86·3	Br. cal. – f. SL. JR. Low squama.
138	—	—	104·5	547·5	38·8?	33·5	54·7	74·2	—	—	—	86·3	Cal. – f. SR. JR. Strong inion. Sutu
121	115	121	97·5	535·5	37·9	—	57·5	73·9	71·0	104·0	2·9	—	Br. cal. – f. SR.
131	111	110	105·5	531	40·1	32·0	57·4	74·2	65·9	112·5	8·3	79·8	Br. cal. – f. SR. Projection (? inion)
120	121	113	97	542?	30·5	—	57·7	70·8	65·7	107·7	5·1	—	Br. cal. – f. Slight bathrocephaly.
—	115	111·5	—	527	—	—	—	81·2	—	—	—	—	Br. cal. – f. SR. Partly healed injury
116	104	108·5	94·5	503	—	—	58·2	77·9	—	—	—	—	Br. cal. – f. SR. Long frontal proces
111	119·5	127	91	563	36·7	31·0	58·6	74·1	65·1	113·8	9·0	84·5	Br. cal. – f. SR.
149??	111·5	—	—	522?	38·9	31·0	—	67·3	66·5	101·2	0·8	79·7	Br. cal. – f. Aged. S equal. JR. Ma
118	117	116·5	92·5	518	37·8	26·5	56·0	77·6	70·2	110·5	7·4	70·1	Cal. – f. SR. JL.
128	112	112	97·5	523	35·5	30·1	54·9	77·3	68·1	113·5	9·2	84·8	Cal. – f. S equal. JR. Interparietal b ascending process from R. squama
126	110·5	114	99	527	34·5	29·4	56·1	73·8	66·9	110·2	6·9	85·2	Cal. – f. SR. JL. Small pars-occipita
102	113	121·5	—	554	—	—	—	79·9	64·1	124·6	15·8	—	Br. cal. – f. SR. JR. Bathrocephaly
121	112	116	101	525	33·1	28·6	60·2	74·9	68·8	108·9	6·1	86·4	Cal. – f. SR. JR.
117·5	116	126·5	97	540	35·4	—	59·2	70·6	67·0	105·3	3·6	—	Br. cal. – f. S equal. Moderate inion.
118	116	116	—	501?	—	—	—	74·3	65·1	114·2	9·2	—	Br. cal. – f.
118	111·5	112	96·5	512·5	41·0	31·2	58·5	69·8	68·3	102·3	1·5	76·1	Br. cal. – f. JR. Moderate inion. Slig
130	113	118·5	107	549	42·5	—	59·0	71·2	69·0	103·3	2·2	—	Br. cal. – f.
118	110?	104·5	96·5	524	—	—	58·5	84·3	—	—	—	—	Br. cal. – f. SR. Moderate inion.
—	115	125·5	—	529?	—	—	—	78·3	—	—	—	—	Br. cal. – f. SR. R. frontal prominer L. fronto-parietal suture 20 × 15 m
133	—	117	102·5	543??	—	—	55·3	—	—	—	—	—	Dome. Strong inion.
—	116·5	113·5	—	524	—	—	—	80·2	—	—	—	—	Br. cal. – f. S equal. L. squama very
—	108	113·5	—	531	—	—	—	73·3	—	—	—	—	Dome. Slight occipital torus.
123	105·5	120	97	523?	—	—	56·3	72·7	—	—	—	—	Br. cal. – f. Moderate inion.
136	117	119·5	106·5	565?	—	—	56·0	72·0	62·4	115·2	9·6	—	Dome. Moderate inion.
120	119·5	117·5	96	541	—	—	57·1	76·6	—	—	—	—	Br. cal. – f.
123	107·5	117·5	99	546	—	—	57·4	76·6	—	—	—	—	Dome. Depression of obelion
—	122·5	104·5?	—	531	—	—	—	64·7	62·1	104·0	2·6	—	Br. cal. – f. S equal. Occipital torus.
113?	117·5	110·5	97?	521	—	—	63·2	72·0	—	—	—	—	Dome.
122	115	125·5	98·5	542?	39·5	30·1	57·6	78·4	71·4	109·9	7·0	76·2	Br. cal. – f. R. frontal flattening. Slig Distinct mastoidal groove.
115	110·5	115·5	99	520	35·2	28·7	63·5	70·1	68·8	101·9	1·3	81·5	Cal. – f. SR. JL. Little ossicle of bre
125	101	121	101·5	533	39·0	34·0	57·9	74·5	63·4	117·6	11·1	87·2	Cal. – f. SR. JR. Frontal process to
109	119·5	117	91·5	535?	42 ɔ	31·4	60·7	76·1	69·0	110·4	7·1	74·8	Br. cal. – f. JR. Ossicle of L. pterion
120	111·5	118	99·5	529	37·1	29·8	59·6	74·3	72·2	102·9	2·1	80·3	Br. cal. – f. J equal.
118	114	118·5	98·5	—	—	—	60·2	75·7	—	- -	—	—	Dome.
115	107	121	89·5	518	38·1	32·4	55·7	75·6	69·3	109·1	6·3	85·0	Cal. – f. SR. JR. Vestiges of ossicle
103	113?	122·5	88	—	—	—	62·7	—	—	—	—	—	Br. dome. Ossicle of λ 26 × 29 mm.
124	116	108·5	97·5	514	36·2	29·2	56·1	72·8	73·4	99·3	−0·6	80·7	Cal. – f. R. temporal squama process
112	107	110	90·5	519	36·5	—	57·6	74·0	66·9	110·6	7·1	—	Br. cal – f. SR. Bathrocephaly.
123	119·5	114	99·5	530	41·2	35·6	57·7	80·4	72·0	111·8	8·4	86·4	Cal. SR. JR. Moderate inion.
118	—	118·5?	95·5?	—	34·4	—	57·7	—	—	117·4	—	—	Br. cal. – f. JR. Slight occipital toru
117	108	102·5	93	499	33·2	26·8	56·7	74·7	73·6	101·5	1·1	80·7	Cal. – f. SL. JR. Metopic suture. L
113	103·5	108·5	97·5	506	39·5	31·2	63·9	82·4	69·0	119·3	13·4	79·0	Cal. – f. S equal. JR. Spine of spher
115	114·5	115·5	95·5	512	30·0	24·2	59·7	76·4	73·1	104·5	3·3	80·7	Cal. – f. J equal. Bathrocephaly. Fo
125	111	108·5	98·5?	—	35·0	31·0	56·3	77·6	74·2	104·5	3·4	88·6	Br. cal. – f.
106	108·5	116	89	524	37·1	35·2	60·7	80·1	65·7	121·8	14·4	94·9	Cal. – f. Diseased. S equal. J equal.
130	116	110·5	106	—	32·8	29·5	58·3	75·9	67·5	112·4	8·4	89·9	Br. cal. – f. JR. R. pterygo-spinous 2 ossicles of R. lambdoid suture.
110	108·5	103·5	90	493	32·0	29·5	58·5	74·6	67·2	110·9	7·4	92·2	Cal. – f. S equal. JL.
—	111	108·5	—	—	—	—	—	75·3	—	—	—	—	Dome. Inion distinct.
—	123·5	—	—	—	—	—	—	—	—	—	—	—	Frag.
120	—	114	93·5	—	—	—	55·8	—	—	—	—	—	Frag. Bathrocephaly.
—	—	114·5	—	—	—	—	—	73·6	—	—	—	—	Dome.
121	109·5	106·5	98·5	—	—	—	58·2	—	—	—	—	—	Dome. Metopic suture. LF + RP 10 m
—	110·5	—	—	—	—	—	—	—	—	—	—	—	Part dome.
—	105·5	—	—	—	—	—	—	—	—	—	—	—	Dome.
118	—	113·5	89·5	—	—	—	54·8	—	—	—	—	—	Part dome. Bathrocephaly. Flattenin
119	—	111	94·5	—	—	—	56·7	—	—	—	—	—	Frag.
—	113	—	—	—	—	—	—	—	—	—	—	—	Part dome.
122	104	108	97	—	—	—	56·7	—	—	—	—	—	Dome.
119	107·5?	116	96·5	—	—	—	57·9	—	—	—	—	—	Dome.
117	—	112	94	—	—	—	57·3	—	—	—	—	—	Dome. Young adult. Bathrocephaly.
—	107·5	116·5	—	—	—	—	—	—	—	—	—	—	Dome.

	REMARKS
	. Well developed ridge on inner side of digastric fossa and petro-mastoid process on L. side.
	on strong. Long sphenoidal process to parietal bone and frontal bulging on L. side.
	lian occipital torus. Post-coronal depression.
	J equal. Faint post-coronal depression. Flattening of obelion.
	. Median occipital torus. Two precondylar eminences.
	JL.
	etopic suture above and below. Very slight RP + LF contact.
	ong inion.
	. Bathrocephaly. Ossicle of lambda. Low squama. Platibasic.
	Low squama. Well marked mastoidal groove on L. side.
	rong inion. Sutures obliterated.
	jection (? inion) 37 mm. from opisthion. Low squama. Slight post-coronal depression.
	athrocephaly.
	rtly healed injury on R. frontal bone. Perforation of L. tympanic plate. Ossicle in lambdoid suture.
	ng frontal process to parietal bone.
	equal. JR. Mastoidal sulcus marked. Slight post-coronal depression. Sutures obliterated.
	. Interparietal bone with traces of separation into pentagonal and triangular bone. Post-coronal depression. Small
	from R. squama 15 mm. behind coronal suture. Metopic suture. LF + RP 7 mm.
	nall pars-occipital process.
	. Bathrocephaly. Traces of ossicle of upper posterior corner of L. parietal. Flattening of obelion.
	Moderate inion.
	derate inion. Slight bathrocephaly.
	derate inion.
	frontal prominence and occipito-parietal flattening. Bathrocephaly. Ossicle of lambdoid suture and at centre of
	suture 20 × 15 mm. Distinct inion.
	L. squama very small. Traces of ossicle replacing upper angle of occipital squama. Flattening of obelion.
	l torus.
	e inion.
	n.
	obelion
	Occipital torus. Lower occipital flattening.
	al flattening. Slight bathrocephaly. Ossicle of λ and traces of ossicles in post-sagittal area and in lambdoid suture.
	groove.
	ittle ossicle of bregma 15 × 15 mm. Frontal process to R. parietal.
	rontal process to L. parietal. Depression of obelion.
	icle of L. pterion. Depression of obelion.
	estiges of ossicle of λ. Cribriform tympanic plate.
	λ 26 × 29 mm.
	l squama process meeting frontal bone.
	hrocephaly.
	ate inion.
	ght occipital torus.
	etopic suture. LF + RP 8 mm.
	R. Spine of sphenoid pierced transversely.
	athrocephaly. Foramen (? emissary) in lower part of L. squama. Small ossicle of λ.
	equal. J equal.
	pterygo-spinous bridge nearly complete. Marked mastoidal groove. Ossicle of L. lambdoid suture 40 × 20 mm.
	nbdoid suture.
	.
	e. LF + RP 10 mm. L. frontal flattening. Flattening of obelion.
	phaly. Flattening of obelion.
	Bathrocephaly. Post-coronal depression. Marked inion.

			Lengths						Arc			
No.	Sex	*C*	*F*	*L*	*B*	*B′*	*H′*	*LB*	*S*	S_1	S_2	S_3
140	♀	—	—	—	143	92·5	—	—	—	—	125	137
146	,,	—	182?	—	136·5	90?	—	—	—	—	128·5	113
147	,,	—	—	—	142·5	90	—	—	—	131	—	—
148	,,	—	184	185·5	—	90·5	—	—	370	129	123	118
149	,,	—	180·5	181	139	91·5	—	—	368·5	131	119·5	118
150	,,	—	182	183·5	135	91·5	129	89	375	133	131	111
151	,,	—	181	183·5	—	100·5	—	—	359	125	125	109
152	,,	—	170·5	170·5	130	92	—	—	—	119·5	111	—
248	,,	—	184	185·5	134·5	100·5	132·5	100	372	126	126	120
249	,,	—	185·5	187·5	141	94·5	—	—	374	128	127	119
250	,,	1348·5?	188	190·5	137	94·5	113·5	88·5	384	123	139	122
252	,,	1267	185	187·5	128·5	91·5	115·5	96	367	120	134	113
254	,,	—	185·5	188·5	151	101	118·5	101·5	371	131	132	108
255	♀?	1351?	—	—	139·5	—	119	—	—	—	141	110
256	♀	1399·5?	185	188·5	144	98	124	99	370	136	125	109
258	,,	—	182	184·5	131·5	99·5	128	103·5	349	122	110	117
259	,,	1280?	181·5	183	137·5	93	126	97·5	363	125	127	111
260	,,	—	—	—	137·5	96·5	111·5?	—	—	—	122	124
261	,,	—	187·5	188	136	94·5	127·5	98	379	131	129	119
262	,,	—	181	—	136	—	126·5	—	—	—	123	106
263	,,	—	181·5	181	136	91	119·5	95·5	361	124	126	111
264	,,	1613?	187	—	144·5	96·5	125	—	—	—	127	128
265	,,	1353·5?	188	188·5	136	96·5	—	—	369	120	125	124
266	,,	1085?	175·5	—	127·5	89	117	—	—	—	116	118
267	,,	1519	183·5	186·5	145·5	98	128·5	98	375	129	134	112
268	,,	—	182	186·5	137·5	97	122	97	363	117	128	118
269	♀?	1381·5	185·5	185·5	139·5	100·5	111	91·5	369	124	124	121
270	,,	1398	179·5	182·5	141	98	127·5	103	357	132	124	101
271	♀	1423·5?	180	184·5	142·5	91·5	125·5	97·5	366·5	128	123	115·5
272	,,	1333·5	179	180	135	96	117	93	362	121	129	112
273	,,	—	179·5	184	140·5	91·5	125·5	101·5	363	122	121	120
274	,,	—	183·5	184·5	141	98·5	120·5	94·5	366	123	126	117
275	,,	—	191·5	191·5	137·5	98	127·5	101	380	125	133	122
276	,,	1318	185·5	186·5	133·5	97	131	99	372	126	133	113
277	,,	—	180·5	182·5	137·5	90·5	131·5	97	376	135	131	110
278	,,	1402	182·5	186	142·5	96·5	124·5	95	376	127	128	121
279	,,	1434	182	185·5	142·5	97·5	132	96	378	125	138	115
280	,,	1393?	179·5	183·5	135	93·5	—	—	366	122	135	109
281	,,	—	187·5??	192·5??	139·5	—	128·5	98·5	380??	131	132	117??
282	,,	—	181	183·5	—	101·5	—	—	—	116	120	—
283	,,	1427·5	185·5	187·5	136·5	94·5	133	98	381	133	125	123
284	♀?	1393?	182	186·5	133·5	92	128·5	105	363	122	119	122
285	♀	1440	178	180	143	98·5	136	97	368	133	126	109
286	,,	1319·5	189	190·5	130·5	102·5	118·5	102·5	360	118	126	116
287	,,	—	185	187·5	145	92	124·5	90·5	—	130	129?	—
288	,,	1261·5	180	185	136·5	95	125·5	94·5	374	128	136	110
291	,,	1278·5?	182	181·5	131	92·5	119·5	—	—	—	125	113
293	,,	—	176·5	—	145·5	93·5	118·5	—	—	—	109	128
294	,,	1301·5?	179·5	182·5	128	86·5	129	100	380	129	137	114
297	,,	1338·5?	182	182·5	135·5	97·5	124	93	363?	122?	126	115
298	,,	1276?	177	179·5	134	92·5	131·5	98·5	361	120	128	113
300	,,	1236·5	176·5	177·5	137	92	123	98·5	354	120	113	121
301	,,	1236·5	170	168	126·5	88	119·5	83	363	122	133	108
302	,,	—	170·5	171·5	133	97·5	125·5	96	353	118	121·5	113·5
303	,,	1166·5?	171·5	172·5	132	90·5	123	96·5	342	121	116	105
304	,,	1415?	179·5	181	145·5	92	120·5	97·5	359	122	123	114
305	,,	1343·5	188·5	188·5	138	94·5	128·5	96·5	381·5	139	135?	107·5?
306	,,	1276	173	174·5	132	88	128	98	344	125	117	102
307	,,	1297·5	181·5	184	134	95·5	123	100	359·5	126·5	115	118
308	,,	1229	179	180·5	133·5	93	117	93·5	357	127	124	106
309	,,	1318?	179·5	177·5	144·5	91·5	117·5	87	360	132·5	125	102·5

Arcs							Foramen		Indices						
S_1	S_2	S_3	S_1'	S_2'	S_3'	U	*fml*	*fmb*	*Oc.I.*	*B/L*	*H'/L*	*B/H'*	$\frac{B-H}{L}$	*fmb/fml*	
—	125	137	—	114	105	—	—	—	55·1	—	—	—	—	—	Br. cal. – f. Slig
—	128·5	113	—	116	91	511	—	—	57·4	—	—	—	—	—	Dome. Wormian
31	—	—	115	—	—	—	—	—	—	—	—	—	—	—	Dome. S equal.
29	123	118	112·5	109	92	—	—	—	55·8	—	—	—	—	—	Dome.
31	119·5	118	110	107·5	95·5	516	—	—	57·7	76·8	—	—	—	—	Br. cal. – f.
33	131	111	114·5	115	94·5	509	38·3	29·0	62·1	73·6	70·3	104·7	3·3	75·7	Br. cal. – f.
25	125	109	107	109·5	88	—	—	—	57·6	—	—	—	—	—	Br. cal. – f. Met
19·5	111	—	100·5	98	—	489	—	—	—	76·2	—	—	—	—	Dome. Traces of
26	126	120	109	114·5	99	516?	34·3	28·9	59·2	72·5	71·4	101·5	1·1	84·3	Br. cal. – f. Bat
28	127	119	110·5	113·5	92·5	519	—	—	55·7	75·2	—	—	—	—	Br. cal. – f. Bat
23	139	122	108·5	123	95	524	32·9	29·2?	55·7	71·9	59·6	120·7	12·3	88·8	Br. cal. – f. J e
20	134	113	104	118·5	92	515	34·8	28·9	58·2	68·5	61·6	111·3	6·9	83·0	Cal. – f. SR. J LF + RP 2 m
31	132	108	115·5	114·5	87·5	542	34·8	28·2	57·8	80·1	62·9	127·4	17·2	81·0	Br. cal. – f.
—	141	110	—	119·5	95	525	30·9	29·0	64·0	—	—	117·2	—	93·9	Cal. – f. S equa
36	125	109	117·5	113·5	90	526	37·1	27·3	59·2	76·4	65·8	116·1	10·6	73·6	Cal. – f. SR. J
22	110	117	109·5	101·5	99	511	39·0	33·2	61·5	71·3	69·4	102·7	1·9	85·1	Br. cal. – f.
25	127	111	106	114·5?	92	517	35·0	28·8	59·5	75·1	68·9	109·1	6·2	82·3	Cal. – f. JL. M
—	122	124	—	105·5	103	—	37·0	32·0	59·7	—	—	123·3	—	86·5	Br. cal. – f. Fla
31	129	119	112	116	98·5	527	38·9	—	59·4	72·3	67·8	106·7	4·5	—	Br. cal. – f. SR
—	123	106	—	108	89	518	38·0	32·2	60·7	—	—	107·5	—	84·7	Br. cal. – f.
24	126	111	104·5	115·5	88	513?	34·0	29·5	56·6	75·1	66·0	113·8	9·1	86·8	Br. cal. – f. S e
—	127	128	—	114·5	107·5	533	39·1	32·1	60·7	—	—	115·6	—	82·1	Br cal. – f. JL.
20	125	124	105·5	113·5	97	528	—	—	55·9	72·1	—	—	—	—	Br. cal. – f. SR
—	116	118	—	103	97	494	32·9	28·5	58·7	—	—	109·0	—	86·6	Cal. – f. SL. J
29	134	112	112	117·5	95	530	34·9	32·8	61·8	78·0	68·9	113·2	9·1	94·0	Cal. – f. SR. J
17	128	118	104·5	114	95·5	516?	37·9	29·8	57·7	73·7	65·4	112·7	8·3	78·6	Br. cal. – f. J e
24	124	121	107·5	111	92	530	35·1	31·3	54·8	75·2	59·8	125·7	15·4	89·2	Cal. – f. S equa
32	124	101	115·5	109?	84·5?	518	38·4	32·0	60·4	77·3	69·9	110·6	7·4	83·3	Cal. – f. S equa
28	123	115·5	114	107	96	515	37·8	28·4	59·8	77·2	68·0	113·5	9·2	75·1	Cal. – f. SR. J
21	129	112	106	115·5	93·5	505	37·3	29·7	60·2	75·0	65·0	115·4	10·0	79·6	Cal. – f. SR. J
22	121	120	108	109	97·5	518	34·8	30·9	58·0	76·4	68·2	112·0	8·2	88·8	Br. cal. – f. SR
23	126	117	107·5	109	93	516	36·5	30·0	56·7	76·4	65·3	117·0	11·1	82·2	Br. cal. – f. S e
25	133	122	107	120	98	—	37·5	30·6	57·3	71·8	66·6	107·8	5·2	81·6	Br. cal. – f. SR
26	133	113	109	118	93	510	35·0	27·8	59·0	71·6	70·2	101·9	1·4	79·4	Br. cal. – f. SR
35	131	110	115·5	114	90·5	—	32·5	28·0	56·0	75·3	72·1	104·6	3·2	86·2	Br. cal. – f.
27	128	121	112·5	115	94·5	520	32·8	26·0	55·9	76·6	66·9	114·5	9·7	79·3	Cal. – f. S equa
25	138	115	109·5	120·5	98	519	35·0	29·0	62·3	76·8	71·2	108·0	5·6	82·9	Cal. – f. SR. J
22	135	109	109	114·5	93	512	—	—	62·4	73·6	—	—	—	—	Br. cal. – f. SL
31	132	117??	115·5	117	92·5	—	35·9	32·5	56·4	72·5	66·8	108·6	5·7	90·5	Br. cal. – f. J
16	120	—	102	108·5	96·5	—	—	—	—	—	—	—	—	—	Br. cal. – f. Ma
33	125	123	115	113·5	100·5	522	39·0	32·1	58·4	72·8	70·9	102·6	1·9	82·3	Cal. – f. SR. J
22	119	122	109·5	105·5	100	514	39·0	31·4	58·6	71·6	68·9	103·9	2·7	80·5	Br. cal. – f. JF
33	126	109	112·5	112·5	88	512	37·1	30·1	57·6	79·4	75·6	105·1	3·8	81·1	Cal. – f. J equ
18	126	116	106·5	114·5	98·5	529	38·0	30·8	61·9	68·5	62·2	110·1	6·3	81·1	Cal. – f. SL. J
30	129?	—	116	113·5?	—	524??	—	32·0	—	77·3	66·4	116·5	10·9	—	Br. cal. – f.
28	136	110	115	119	91	510	31·8	27·1	59·4	73·8	67·8	108·8	6·0	85·2	Cal. – f. S equ
—	125	113	—	111·5	87·5	502	35·5	27·8	55·5	72·2	65·8	109·6	6·4	78·3	Br. cal. – f. JE
—	109	128	—	101	96	510	30·9	30·0	54·4	—	—	122·8	—	97·1	Br. cal. – f. JE
29	137	114	115·5	119	94	499	30·9	28·3	59·1	70·1	70·7	99·2	−0·6	91·6	Br. cal. – f. S
22?	126	115	110?	113	94·5	513	35·0	28·9	58·8	74·2	67·9	109·3	6·3	82·6	Br. cal. – f. SE
20	128	113	106	112	95·5	498	35·5	30·5	49·8	74·7	73·3	101·9	1·4	85·9	Br. cal. – f. JE
20	113	121	106·5	101	100	503	36·5	27·8	59·3	77·2	69·3	111·4	7·9	76·2	Br. cal. – f. SI
22	133	108	104·5	112·5	90·5	482?	31·5	29·6	60·5	75·3	71·1	105·9	4·2	94·0	Cal. – f. S equ
18	121·5	113·5	104	106·5	100	484?	33·3	30·1	67·2	77·6	73·2	106·0	4·4	90·4	Br. cal. – f.
21	116	105	106	102·5	90	486	34·0	29·4	63·0	76·5	71·3	107·3	5·2	86·5	Cal. – f. S equ
22	123	114	106	108	91·5	519	32·0	30·9	57·2	80·4	66·6	120·7	13·8	96·6	Cal. – f. S equ pterion. Ma
39	135?	107·5?	114	121·5?	90·5?	526	35·0	27·0	61·0	73·2	68·2	107·4	5·0	77·1	Cal. – f. S equ
25	117	102	104·5	105	84·5	496	38·6	33·0	59·5	75·6	73·4	103·1	2·2	85·5	Cal. – f. S equ
26·5	115	118	111·5	121·5	97·5	508	33·7	31·2	59·3	72·8	64·8	108·9	8·0	92·6	Cal. – f. SR.
27	124	106	109·5	111	87·5	504	30·0	26·2	59·2	74·0	66·8	114·1	7·2	87·3	Cal. – f. SR.
32·5	125	102·5	109·5	111·5	87·5	516·5	35·0	27·8	62·6	81·4	66·2	123·0	15·2	79·4	Br. cal. – f. JI of λ 20 × 12

REMARKS
Br. cal. – f. Slight bathrocephaly. Diseased frontal bone.
Dome. Wormian bone in posterior sagittal suture.
Dome. S equal.
Dome.
Br. cal. – f.
Br. cal. – f.
Br. cal. – f. Metopic suture. No noticeable deviation in cruciform sutures.
Dome. Traces of whole length of metopic suture. LF + RP 10 mm.
Br. cal. – f. Bathrocephaly.
Br. cal. – f. Bathrocephaly. Well marked mastoidal groove.
Br. cal. – f. J equal. Ossicle of pterion on R.
Cal. – f. SR. J equal. Small linguiform process on occipital bone. Ossicle of bregma 15 × 10. Trace of upper part of metopic suture. LF + RP 2 mm.
Br. cal. – f.
Cal. – f. S equal. JR. Bathrocephaly. Ossicle of posterior sagittal suture 23 × 15 mm.
Cal. – f. SR. JR. Mastoidal groove well developed.
Br. cal. – f.
Cal. – f. JL. Metopic suture. LF + RP 8 mm.
Br. cal. – f. Flattening of obelion.
Br. cal. – f. SR. Post-coronal constriction. Depression of obelion.
Br. cal. – f.
Br. cal. – f. S equal. JR. Flattening of obelion.
Br cal. – f. JL. Post-coronal depression. Transverse occipital depression.
Br. cal. – f. SR. Ossicle of pterion on R. Well marked Sylvian groove.
Cal. – f. SL. JL. Long frontal process to parietals. Flattening of obelion.
Cal. – f. SR. JR. Slight bathrocephaly.
Br. cal. – f. J equal.
Cal. – f. S equal. JR. Post-coronal depression. Strong inion. L. parieto-frontal overlap.
Cal. – f. S equal. JL. Porus crotaphitico-buccinatorius on L. side.
Cal. – f. SR. JR. Faint bathrocephaly. Slight post-coronal depression.
Cal. – f. SR. JR. Precondylar ridges.
Br. cal. – f. SR.
Br. cal. – f. S equal. JR. Descending frontal process to L. parietal. Post-coronal depression.
Br. cal. – f. SR.
Br. cal. – f. SR.
Br. cal. – f.
Cal. – f. S equal. JL. Long frontal process to parietals. Pterygo-spinous bridge nearly complete on R.
Cal. – f. SR. JL. Slight bathrocephaly. Pterygo-spinous bridge and foramen on right.
Br. cal. – f. SL. Ossicle of λ 19 × 25 mm.
Br. cal. – f. J equal. Diseased. Slight bathrocephaly.
Br. cal. – f. Marked Sylvian groove. Parieto-frontal overlap.
Cal. – f. SR. JR. Marked mastoidal groove.
Br. cal. – f. JR. Marked inion. Remains of ossicle of λ.
Cal. – f. J equal. Slight bathrocephaly. Slight post-coronal depression.
Cal. – f. SL. JR. Depression of obelion. Sylvian and mastoidal grooves well marked. Frontal process to parietal.
Br. cal. – f.
Cal. – f. S equal. JL. Bathrocephaly.
Br. cal. – f. JR. Metopic suture. RF + LP 2 mm.
Br. cal. – f. JR.
Br. cal. – f. S equal. JR. Spine of R. sphenoid pierced transversely.
Br. cal. – f. SR. JR. Healed injury above L. temporal squama.
Br. cal. – f. JR.
Br. cal. – f. SL. JR. Ossicle of R. pterion. Spheno-parietal suture on L. 4 mm.
Cal. – f. S equal. JR. Tympanic foramen R. and L.
Br. cal. – f.
Cal. – f. S equal. JL. Parieto-frontal overlap.
Cal. – f. S equal. JR. Post-coronal depression. Frontal process to L. parietal. Nearly complete pterygo-spinous bridge. Ossicle of R. pterion. Marked mastoidal groove. Ossicle in middle of L. lambdoid 20 × 14 mm.
Cal. – f. S equal. JR. Coronal suture obliterated. Marked opisthial notch. Frontal process to L. parietal.
Cal. – f. S equal. JR. Marked opisthial notch. Indications of metopic suture. Bregma indistinct.
Cal. – f. SR. J equal. Marked Sylvian grooves.
Cal. – f. SR. JR. Depression of obelion. Small precondylar ridge. Ossicle of λ.
Br. cal. – f. JL. Slight post-coronal depression. Upper half of metopic suture obliterated. Ossicle of R. lambdoid 24 × 15 mm. Ossicle of λ 20 × 12 mm.

			Lengths						Ar			
No.	Sex	*C*	*F*	*L*	*B*	*B′*	*H′*	*LB*	*S*	S_1	S_2	S_3
310	♀	1389·5	181	181	137·5	93·5	129	95·5	372·5	128	120·5	124
311	,,	1202	179·5	178·5	133	93	119	98·5	349	118	118	113
312	,,	—	182·5	184·5	—	88	115·5	92	371	124	117	130
313	,,	1291·5	180·5	182·5	144	97	117	97·5	351	125	112	114
314	,,	1395·5?	186?	183·5?	138	92	126·5	98	374	122	130	122
315	,,	1299	182·5	182·5	134	97·5	128	102·5	370	131	121	118
316	,,	1353·5	181·5	184	137·5	94	125	90·5	377	127	132	118
317	,,	1264·5	172	175	141	97?	123·5	84·5?	379	124	127·5	127·5
318	,,	1371·5	181	183	141	91·5	127·5	93·5	382·5	137·5	133	112
319	,,	—	174·5	173	139	93	121·5	96	350	121·5	124	104·5
320	,,	1439	185	186·5	144·5	95·5	122·5	91	380	129	128	123
321	,,	1341	186·5	190·5	134	95·5	118·5	105	364	132	122	110
322	,,	—	187·5	191	132	99·5	122·5	104·5	367	120·5	127·5	119
323	,,	1365	181·5	182	141·5	92	125·5	98	363	125	117·5	120
324	,,	1238	186	186·5	127·5	91	120·5	97	372	132	125	115
325	,,	—	179·5?	183?	132	92·5	119·5	96·5	361	121	118	122
326	,,	1347·5?	184	184	133	93·5	123·5	95·5	368	126	112	131
327	,,	1311·5?	178·5	177	137·5	88·5	123	90	364	119	132	113
328	,,	1337	179	182·5	139·5	90·5	123·5	100·5	359	120	120	119
329	,,	1273·5?	181·5	182·5	136·5	96·5	117	97	371	126	119	126
330	,,	1393	178	178	141·5	91·5	121·5	84·5	377·5	135·5	134	108
331	,,	1133·5	168·5	171	129·5	87·5	115	92·5	345	126	108	111
332	,,	1303?	182·5	184·5	137	89·5	128·5	97·5	366	127	121	118
333	,,	1282·5?	167·5	170·5	132	86·5	117	90·5	340	113	108	119
334	,,	1158	175	182	140·5	94·5	106·5	—	—	—	111	119
335	,,	—	177·5	178·5	128·5	95·5	125·5	93·5	361	125	118	118
336	,,	—	177	178	125·5	86	115	86·5	363	130	122	111
337	,,	1320·5	181·5	183·5	131·5	90·5	127	95	370·5	134	131	105·5
338	,,	1440?	195	194·5	143	100·5	127	101·5	389	128	138	123
339	,,	1145?	172·5	175·5	127	88	117·5	94	348	122	109	117
340	,,	—	180·5	184	138·5	88	116	91	361·5	128	125	108·5
341	,,	1174·5	179·5	182	132	91	126·5	102	358	120	124	114
342	,,	—	171·5	173	—	93·5	126·5	92	371·5	129	136	106·5
343	,,	—	182	182·5	141	93	131·5	96·5	375	132	127	116
344	,,	1322?	187·5	189·5	134	90	120	97·5	374	119	127	128
345	,,	—	182·5	186	134	93	122	96·5	366	120	131	115
346	,,	—	176	180·5	127·5	91·5	116	94·5	—	120	115·5	—
347	♀?	—	181·5	184·5	135·5?	88	—	—	373	132	122	119
348	,,	—	192·5	195·5	144	92·5	—	—	384	138	125	121
349	,,	—	—	—	—	—	—	—	—	—	115	120
350	,,	—	190·5	193·5	—	91	—	—	378	133	129	116
351	,,	—	183	185	130	100	—	—	—	128	120·5	—
352	,,	1310·5	178	181	134·5	92·5	120	93	361	121	121	119
353	,,	—	—	—	137·5	—	—	—	—	—	124	—
354	,,	—	—	—	—	—	—	—	—	—	116	106
355	,,	—	174	177·5	130	91	—	—	—	116	117	—
356	,,	—	182·5	182·5	—	96·5	—	—	—	—	126·5	—
357	,,	—	—	—	—	—	—	—	—	—	112	—
358	,,	—	182	185·5	—	92·5	—	—	374	128	133	113
359	♀	—	194·5	196·5	—	98·5	—	—	381	122	141	118
360	,,	—	—	—	—	—	—	—	—	—	116	—
361	,,	—	—	—	—	95·5	—	—	—	—	128	—
362	,,	—	—	—	—	91·5	—	—	—	117	—	—
363	,,	—	172·5	174·5	126·5	89	—	—	319	111	122	—
364	,,	—	179·5	178·5	133·5	92	—	—	362	119	129	114
365	,,	—	—	—	141	—	—	—	—	—	124	120
366	,,	—	192	192	134·5	94·5	—	—	—	140	134	—
367	,,	—	179·5	—	130·5	—	121·5	—	—	—	114	123
368	,,	—	—	—	—	89	—	—	—	121	—	—
370	,,	—	183	185	—	92	—	—	364	118	119	127
371	,,	—	187·5	188·5	—	95·5	—	—	—	128	116	—

Arcs							Foramen		Indices						
	S_2	S_3	S_1'	S_2'	S_3'	U	*fml*	*fmb*	*Oc.I.*	*B/L*	*H'/L*	*B/H'*	$\frac{B-H}{L}$	*fmb/fml*	
	120·5	124	109·5	109	99·5	514	36·0	—	57·2	76·0	71·3	106·6	4·7	—	Br. cal. – f. SR. J
	118	113	103·5	106·5	89·5	502·5	34·0	30·2	56·5	74·5	66·7	111·8	7·8	88·8	Cal. – f. SR. JL.
	117	130	110·5	104·5	103·5	—	36·5	30·3	56·8	—	62·6	—	—	83·0	Br. cal. – f.
	112	114	109·5	103	94·5	521	37·8	30·8	59·6	78·9	64·1	123·1	14·8	81·5	Cal. – f. J equal.
	130	122	103·5	115·5	96	518	32·0	29·1	56·2	75·2	68·9	109·1	6·3	90·9	Cal. – f. SR. JR.
	121	118	110·5	109	94·5	509	31·2	27·8	57·1	73·4	70·1	104·7	3·3	89·1	Cal. – f. S equal. J
	132	118	112	117·5	98·5	514	33·0	29·1	60·2	74·7	67·9	110·0	6·8	88·2	Cal. – f. SR. JR.
	127·5	127·5	110?	107·5	103·5	507?	34·2	32·7	57·9	80·6	70·6	114·2	10·0	95·6	Cal. – f. SR. JL.
·5	133	112	119·5	115·5	94	522	33·2	26·5	60·7	77·1	69·7	110·6	7·4	79·8	Cal. – f. SR. J equ
·5	124	104·5	103	107·5	88·5	502	33·9	27·1	61·6	80·3	70·2	114·4	10·1	79·9	Br. cal. – f. SL. M
	128	123	112	112	97	525?	37·6	30·9	56·3	77·5	65·7	118·0	11·8	82·2	Cal. – f. SL. JL.
	122	110	114	108	94	524	36·7	29·5	62·7	70·3	62·2	113·1	8·1	80·4	Cal. – f. SL. JR.
·5	127·5	119	107·5	113	101	524?	36·0	31·7	61·9	69·1	64·1	107·8	5·0	88·1	Br. cal. – f. Spine
	117·5	120	108·5	103·5	99·5	512	30·0	31·0	59·6	77·7	69·0	112·8	8·7	103·3	Cal. – f. S equal. J
	125	115	110·5	113	95	503	35·0	28·9	59·2	68·4	64·6	105·8	3·8	82·6	Cal. – f. SR. JL.
	118	122	105·5?	104·5	101·5	509?	34·4	28·4	59·9	72·1	65·3	110·5	6·8	82·6	Br. cal. – f. SR. J
	112	131	106	104·5	101	510	34·4	28·2	55·3	72·3	67·1	107·7	5·2	82·0	Cal. – f. S equal.
	132	113	102·5	116·5	93	505·5	33·8	—	59·0	77·7	69·5	111·8	8·2	—	Br. cal. – f. S equa
	120	119	104·5	106·5	100	509	37·0	32·0	60·8	76·4	67·7	113·0	8·7	86·5	Cal. – f. SR. JL.
	119	126	110·5	106·5	101	512·5	30·0	27·6	57·1	74·8	64·1	116·7	10·7	92·0	Br. cal. – f. JL. Pa
·5	134	108	115	117·5	84·5	507	27·8	26·9	55·9	79·5	68·3	116·5	11·2	96·8	Cal. – f. S equal. J
	108	111	110	97·5	92·5	484	31·0	26·9	60·0	75·7	67·3	112·6	8·4	86·8	Cal. – f. JL. Tempo
	121	118	115·5	108	98	509·5	36·0	29·9	59·7	74·3	69·6	106·6	4·7	83·1	Br. cal. – f. SL. JI
	108	119	102	98·5	92·5	483	31·8	—	55·7	77·4	68·6	112·8	8·8	—	Br. cal. – f. Depres
	111	119	—	101	92·5	513·5	32·3	30·5	55·7	77·2	58·5	131·9	18·7	94·4	Cal. – f. JR. Spher
	118	118	107	110·5	99	499?	37·4	31·0	60·6	72·0	70·3	102·4	1·7	82·9	Br. cal. – f.
	122	111	104	105·5	92	—	33·8	28·4	59·5	70·5	64·6	109·1	5·9	84·0	Br. cal. – f. L. occi
															3·5 mm. Antero-
	131	105·5	115	114	88	502·5	33·2	27·0	60·0	71·7	69·2	103·5	2·5	81·3	Br. cal. – f. S equa
	138	123	110·5	121·5	101	541	37·1	32·1	58·8	73·5	65·3	112·6	8·2	86·5	Br. cal. – f. SR. JI
	109	117	106·5	98·5	96·5	489	33·5	29·0	59·2	72·4	67·0	108·1	5·4	86·6	Br. cal. – f. J equa
	125	108·5	111·5	111	89	510	39·2	—	58·7	75·3	63·0	119·4	12·3	—	Br. cal. – f.
	124	114	106	108	95·5	504·5	32·1	27·0	60·5	72·5	69·5	104·3	3·0	84·1	Cal. – f. S equal. J
	136	106·5	114	115	87	—	30·0	—	58·4	—	73·1	—	—	—	Br. cal. – f. Posteri
	127	116	114·5	118·5	94	516??	37·0	30·0	57·8	77·3	72·1	107·2	5·2	81·1	Br. cal. – f. Post-co
	127	128	106·5	113	102	515	31·3	29·0	56·8	70·7	63·3	111·7	7·4	92·7	Br. cal. – f. JL.
	131	115	109·5	115	94·5	515	36·0	30·5	58·8	72·0	65·6	109·8	6·4	84·7	Br. cal. – f. JR.
	115·5	—	108·5	105·5	—	496	—	—	—	70·6	64·3	109·9	6·3	—	Br. cal. – f. SR.
	122	119	114	111·5	96·5	—	—	—	57·9	73·4	—	—	—	—	Dome.
	125	121	121·5	113	99	—	—	—	58·6	73·7	—	—	—	—	Dome. Post-coronal
	115	120	—	105	95	—	—	—	56·5	—	—	—	—	—	Dome.
	129	116	117	109·5	96	—	—	—	59·4	—	—	—	—	—	Dome.
	120·5	—	113	107·5	—	—	—	—	—	70·3	—	—	—	—	Dome. Flattening o
	121	119	107·5	108	97	503	37·5	32·0	58·2	74·3	66·3	112·1	8·0	85·3	Cal. – f. S equal. J
															ridges.
	124	—	—	111	—	—	—	—	—	—	—	—	—	—	Dome.
	116	106	—	103·5	88·5	—	—	—	60·2	—	—	—	—	—	Part dome.
	117	—	103	105	—	—	—	—	—	73·2	—	—	—	—	Dome.
	126·5	—	—	114·5	—	519	—	—	—	—	—	—	—	—	Dome. Flattening o
	112	—	—	100·5	—	—	—	—	—	—	—	—	—	—	Dome.
	133	113	107·5	117	90	—	—	—	56·8	—	—	—	—	—	Dome. Occipital tor
	141	118	106·5	124·5	97	—	—	—	58·9	—	—	—	—	—	Dome. Metopic sutu
	116	—	—	104	—	—	—	—	—	—	—	—	—	—	Dome. Depression o
	128	—	—	110·5?	—	—	—	—	—	—	—	—	—	—	Part dome.
	—	—	100	—	—	—	—	—	—	—	—	—	—	—	Part dome.
	122	—	97·5	108·5	—	—	—	—	—	72·5	—	—	—	—	Dome.
	129	114	102·5	114·5	95·5	507?	—	—	60·5	74·8	—	—	—	—	Dome. Metopic sutu
	124	120	—	109	98·5	—	—	—	58·8	—	—	—	—	—	Dome.
	134	—	119·5	119·5	—	538?	—	—	—	70·1	—	—	—	—	Cal. – f.
	114	123	—	105	97·5	—	37·0	28·2	56·5	—	—	107·4	—	76·2	Cal. – f. Plagiocepl
	—	—	106	—	—	—	—	—	—	—	—	—	—	—	Frag.
	119	127	103·5	108	101·5	—	—	—	—	—	—	—	—	—	Dome.
	116	—	111·5	106·5	—	—	—	—	—	—	—	—	—	—	Dome. Metopic sutu

REMARKS
al. – f. SR. JR. Cribriform tympanic plate.
– f. SR. JL.
al. – f.
– f. J equal. Parieto-frontal overlap.
– f. SR. JR. Metopic suture. LF + RP 10 mm. Tympanic foramen R. and L.
– f. S equal. JR.
– f. SR. JR. Small precondylar ridges. Slight metopic ridge in upper third, in lower two-thirds suture persists.
– f. SR. JL.
– f. SR. J equal.
cal. – f. SL. Metopic ridge with suture. LF + RP 5 mm. Flattening of obelion.
– f. SL. JL.
– f. SL. JR. Frontal process to parietal R. and L. Post-coronal constriction.
cal. – f. Spine of sphenoid pierced transversely. Grooved obelion. Parieto-frontal overlap. Post-coronal depression.
– f. S equal. JR.
– f. SR. JL. Two precondylar nodules.
cal. – f. SR. J equal. Slight precondylar ridges.
– f. S equal.
cal. – f. S equal. Tympanic perforation on L.
– f. SR. JL. Slight post-coronal depression.
cal. – f. JL. Parieto-frontal overlap on L. Transverse occipital depression. Ossicle of squamous suture. Marked Sylvian groove.
– f. S equal. J equal. Tympanic foramen on R.
– f. JL. Temporal squama joins frontal bone R. and L.
cal. – f. SL. JR.
cal. – f. Depression of obelion.
– f. JR. Spheno-parietal suture 6 mm.
cal. – f.
cal. – f. L. occipital condylar articular surface divided into two. Anterior surface 11·5 mm. Posterior surface 12 mm. Interval 3·5 mm. Antero-posterior length 24 mm. R. condyle 23 mm.
cal. – f. S equal. J equal.
cal. – f. SR. JR.
cal. – f. J equal. Tympanic foramen R. and L.
cal. – f.
– f. S equal. JR. Marked mastoidal groove R. and L.
cal. – f. Posterior parietal flattening. Cribriform tympanic plate.
cal. – f. Post-coronal depression. Marked mastoidal groove.
cal. – f. JL.
cal. – f. JR.
cal. – f. SR.
me.
me. Post-coronal depression. Ossicles of R. lambdoid 26 × 18 and 10 × 38 mm.
me.
me.
me. Flattening of obelion.
. – f. S equal. JR. Ossicle of lambdoid suture L. 35 × 15, R. 18 × 12 mm. Spine of sphenoid pierced transversely. Small precondylar ridges.
me.
rt dome.
me.
me. Flattening of obelion.
me.
me. Occipital torus.
me. Metopic suture. LF + RP 8 mm. Ossicle of L. lambdoid 20 × 15 mm.
me. Depression of obelion.
rt dome.
rt dome.
me.
me. Metopic suture. LF + RP 8 mm.
me.
l. – f.
l. – f. Plagiocephaly. L. frontal and R. parieto-occipital flattening.
ag.
me.
me. Metopic suture. LF + RP 3 mm.

Lengths with Callipers

No.	w_1	w_2	h_1	zz	c_1c_7	rb	rb'	G_2'	c_3c_7	g_0g_0	$g_0g_0(l)$	$g_0g_0(r)$
501	110·0	—	26·2	47·9	90·6	40·0	34·6	42·1	33·1	—	—	83·1
502	111·4	99·0?	33·0	48·1	99·0	31·9	26·0	48·1??	32·1	85·1	88·3	86·2
503	103·0	89·0	30·3	42·8	102·2	34·5	30·3	—	32·9	88·1	79·1	81·0
504	98·5	92·0	30·0	41·0	86·2	37·9	30·0	41·0?	32·3	78·6	71·2	71·8
505	107·3	82·0	27·0	41·6	—	37·1	32·9	44·0	—	96·0	87·0	84·0
506	104·9	104·8	28·9	45·0	98·9	32·2	29·0	46·9	32·3	102·8	78·9	81·6
507	—	84·0	34·2	43·4	91·9	38·7	33·3	—	37·9	—	84·0	—
508	121·0	94·2	27·7	44·6	—	31·7	30·8	49·8	35·0	90·0	91·2	91·2
510	—	89·1	26·5	41·3	88·9	31·6	28·9	45·3	29·0	84·9	78·2	77·5
511	113·3	92·0	24·9	44·4	99·0	35·1	28·2	44·9	28·4	86·0	81·0	80·4
515	109·0	83·8	29·5	44·0	88·9	31·4	26·1	43·0	31·1	81·0	73·3	75·0
521	116·3	106·1	33·1	45·2	99·0	30·8	27·6	50·0	26·1	103·9	85·1	86·9
524	117·1	94·6	28·9	40·5	86·8	38·2	36·8	36·5	43·4	94·4	85·0	84·1
525	113·9	80·0	29·8	42·2	95·8	35·0	31·0	41·3	28·1	75·9	78·9	77·9
528	—	87·0	31·5	38·5	88·7	30·9	26·0	—	30·0	84·1	74·0	79·1
529	99·2?	81·6	22·1	41·1	81·9	24·9	24·2	47·1	27·1	81·2	66·4	68·9
533	117·1??	97·8	28·1??	45·7	—	30·2	29·1	49·0	—	—	—	86·7
535	104·5	93·0	29·0	44·0	84·0	35·1	31·0	48·2	31·5	91·2	83·5	84·1
540	111·0	89·1	25·6	43·3	—	32·9	31·0	43·6	30·2 (*R*)	85·6	80·4	80·1
544	119·1	90·5	30·9	48·2	—	42·0	40·0	44·4	38·9	87·8	90·8	87·1
547	100·8	78·0	33·0	43·2	89·5	34·1	26·5	47·2	31·9 (*R*)	76·8	73·2	79·9
550	123·0	108·9	37·6	46·2	105·0	36·0	30·4	48·9	33·2	106·0	87·7	92·0
560	117·0	89·8	30·0	43·0	93·4	35·0	31·8	45·6	35·2	87·3	79·9	85·0
567	106·8	94·0	28·2	43·1	87·9	31·9	29·7	42·1	26·1	93·0	81·2	77·0
571	116·0	86·9	36·5	42·1	—	41·0	34·0	45·4	—	83·0	79·4	83·1
581	106·1	89·8	23·3	40·5	87·1	32·0	30·5	42·2	31·2	84·5	75·4	74·8
598	113·1	94·8	25·8	43·0	89·1	36·8	34·1	39·8	37·8	91·5	83·0	82·0
599	108·2	88·8	27·1	45·2	88·5	28·5	25·2	43·3	28·9	86·3	73·4	75·8
606	105·6	88·0	23·0?	41·6	88·0	35·9	30·8	43·1	35·1	85·2	77·0	76·5
607	115·1	92·3?	27·5	43·8	93·0	35·1	30·0	43·2	32·1	88·1?	75·0?	81·2
610	123·8	108·2	28·2	41·5	—	32·0	29·2	42·9	35·3 (*R*)	107·5	88·9	88·0
615	118·0	110·9	32·0	43·0	94·1	36·0	32·0	—	32·8	109·0	89·1	90·0
617	111·0	94·0	29·2	45·5	—	32·8	28·0	—	32·9	90·8	82·0	84·5
619	115·2	106·1	—	46·0	90·0	33·0	29·3	46·0	31·1	103·8	88·8	88·8
622	121·1	105·5	29·6	48·8	98·3	35·9	34·2	48·8	31·9	102·3	93·8	91·2
638	100·0	103·0	30·2	43·8	89·1	35·0	29·6	48·0	31·5	100·8	80·9	85·3
639	118·0	101·2?	29·8	47·0	97·9	34·4	32·0	41·0?	32·6	98·1?	82·4	81·0?
643	122·0?	103·8	—	41·2	—	33·9	31·1	44·9	34·2	100·4	87·0	83·5
645	110·2	104·3	30·8	44·2	94·7	35·9	32·9	46·0	32·9	101·8	88·7	88·1
656	108·5?	102·8	33·4	44·1	95·0	29·0	27·1	51·0	27·1	99·0	80·2	85·5
659	111·6	98·1	26·9	43·1	96·0	28·3	25·9	44·0	29·1	96·0	81·2	80·2
663	120·2	100·0	34·5	43·0	101·2	38·1	33·2	44·4	30·9	98·1	90·2	85·6
664	107·8	89·0	34·0	42·0	93·9	38·2	34·3	—	29·9	84·0	80·9	81·6
665	115·9	107·2	31·1	42·0	93·5	31·6	28·8	45·6	32·2	106·0	85·1	84·9
666	123·4	104·0	32·1	40·0	—	38·0	30·6	—	31·1 (*R*)	101·9	84·6	86·1
667	117·0	116·8	29·1	43·1	—	35·2	31·6	46·0	—	83·4	86·0	84·9
669	—	97·0	35·0	47·2	89·1	33·9	27·1	45·8	29·1	95·1	78·1	81·8
675	118·0	90·1	29·8	43·9	96·3	39·0	31·0	45·5	36·0	86·9	88·1	86·3
678	—	102·1	29·1	48·1	—	36·5	35·1	46·1	—	99·9	93·0	89·5
681	119·0	96·0	29·2	41·0	99·3	34·0	33·7	47·3?	30·0	92·9	83·5	85·2
684	118·3	103·8	32·1	45·3	93·9	36·4	33·1	44·1	31·9	101·0	85·0	84·1
690	105·9	98·9	30·8	44·9	90·1	30·0	27·1	49·0?	30·0	95·1	79·0	80·0
692	108·1	88·0	32·0	43·1	—	31·3	29·0	43·2	26·1 (*R*)	83·7	80·0	80·0
696	100·0?	85·6	31·0	38·9	—	37·2	32·9	—	—	77·9	84·0	84·0
698	—	—	31·0	46·1	105·8	33·9	25·8	44·0	30·9	—	—	—
701	105·1	88·6	28·0	47·9	88·0	35·5	28·0	43·0	30·0	86·5	79·2	81·1
704	119·1	109·2	—	44·5	97·2	35·0	32·6	45·7	30·2	107·0	89·5	88·9
705	112·6	96·7	33·6	45·0	91·1	38·0	30·8	47·0	29·6	94·0	82·6	81·1
706	109·6	98·1	32·7	41·9	94·8	35·2	31·5	53·1	33·0	96·0	88·0	89·2
707	115·1	109·1	33·4	45·5	—	34·0	31·1	46·7??	36·9 (*R*)	107·3	91·7	94·5
708	107·7	93·4	29·1	44·0	93·1	36·0	30·3	—	30·6	90·0	87·7	89·1
709	117·6	104·2	32·9	46·0	91·8	36·0	33·0	49·1	32·1	100·6	91·8	90·4
715	107·5	91·6	31·6	44·3	90·0	38·9	31·0	43·9	31·9	88·0	80·4	80·4
719	109·2	—	31·1	47·9	92·0	41·5?	—	37·0?	32·0	—	—	—
722	—	97·6	26·1	45·7	95·2?	32·9	28·9	49·8	—	—	—	—
723	—	94·0	27·6	45·6	—	31·9	26·8	46·9	33·5	92·0	77·9	80·1
726	102·8	90·3	29·1	47·0	84·5	40·0	33·3	45·2	36·2	85·3	84·0	82·0

Callipers									Tape	Lengths and Heights				
g_1g_2 (*l*)	g_2g_2 (*r*)	c_1l	c_1b	m_2p_1	p_1d_1	p_2g_2	p_2d_1	g_2d_1	$g_2p_2g_2$	*ih*	*ih'*	c_1h	c_2h	d_1h
—	83·1	19·1	7·1	27·8	23·0	7·0	18·9	22·9	—	41·9	12·8	61·0	52·0	27·1
88·3	86·2	18·8	8·9	—	31·1	4·0	28·1	30·1	200	34·6	15·0	54·1	49·8	37·3
79·1	81·0	20·8	9·9	—	27·2	5·8	25·0	28·9	187	45·0	14·0	61·4	54·6	31·5
71·2	71·8	16·0	6·9	—	25·4	6·1	21·9	27·0	163	36·8	12·0	54·7	42·8	32·1
87·0	84·0	16·2 (*R*)	7·0 (*R*)	27·0	22·1	7·2	18·0	23·4	195	34·9	—	53·1	46·4 (*R*)	29·8
78·9	81·6	18·1	7·9	28·0	28·8	6·9	25·9	30·0	177·5	43·2	13·8	65·6	49·9	31·6
84·0	—	—	11·0	—	35·0	6·2	24·5	27·0	—	43·1	17·0	63·5	58·6	36·8
91·2	91·2	21·9	10·0	31·2	28·0	2·2	27·7	27·6	219	44·1	15·7	61·0	59·8	29·8
78·2	77·5	16·0	7·0	29·8	26·9	4·6	24·4	26·5	179	39·5	11·2	52·2	49·6	30·9
81·0	80·4	17·1	7·1	29·2	21·1	6·3	17·0	22·0	189·5	33·5	11·9	51·3	39·9?	31·5
73·3	75·0	14·9	9·0	21·4	26·7	5·8	24·9	27·8	170·5	34·8	10·8	52·8	38·9	30·2
85·1	86·9	—	11·0	30·0	32·8	3·9	29·6	30·9	191·5?	49·0	11·1	63·2	60·2	35·0
85·0	84·1	21·8	8·1	27·1	26·0	4·3	23·0	25·9	181·5	43·1	13·0	63·2	56·5	30·1
78·9	77·9	18·1	8·8	24·8	26·0?	5·8	21·9	26·0	192·5	43·0	10·9	61·2	48·2	29·7
74·0	79·1	17·3?	9·9	—	28·8	4·9	25·9	28·9	171	39·4	12·4	54·6	43·7	33·6
66·4	68·9	—	—	25·2	21·0	2·9	18·5	19·9	150	34·2	10·6	49·5	40·8	22·2
—	86·7	19·0 (*R*)	8·0	38·2	24·2??	5·9	20·6	25·0	—	51·9	12·0	71·4 (*R*)	67·1 (*R*)	29·8?
83·5	84·1	17·5	10·0	29·9	26·1	5·0	22·1	25·1	190·5	39·3	10·8	52·0	46·0	30·2
80·4	80·1	17·9	7·1	26·0	19·6	7·0	18·0	23·9	185	38·1	—	—	42·1	27·1
90·8	87·1	21·8	10·1	29·5	26·0	7·9	23·0	27·6	206	49·4	14·0	68·1	61·4	32·5
73·2	79·9	16·2 (*R*)	8·6 (*R*)	26·7	30·1	7·9	26·0	29·0	183·5	35·1	12·9	57·2	45·3	35·9
87·7	92·0	21·3	8·9	28·1	35·1	4·1	33·8	35·8	199·5	46·8	12·5	63·9	56·9	41·0
70·9	85·0	15·2	8·1	27·2	28·0	5·0	23·9	26·0	192	38·2	17·3	61·2	52·0	28·9
81·2	77·0	19·0	9·8	26·0	22·8	7·8	19·1	25·0	179	44·0	10·2	56·2	51·3	31·0
79·4	83·1	17·0	9·0	27·0	33·1	6·0	32·2	35·6	191	46·0	—	64·5?	53·2	37·5
75·4	74·8	19·1	10·0	25·8	17·1	8·0	16·2	21·0	174·5	41·8	10·2	55·1	52·0	26·0
83·0	82·0	19·3	9·4	27·4	21·1	5·2	19·9	24·1	184	42·8	13·5	57·1	56·8	28·0
73·4	75·8	16·5	6·6	22·9	24·3	4·8	20·0	23·0	171·5	39·4	10·9	55·6	47·2	28·0
77·0	76·5	16·9	8·6	27·2	20·8?	5·0	20·0	76·8	174	32·8	13·5	55·1	40·3	23·7
75·0?	81·2	19·0	11·1	26·0	25·0	5·0	24·1	26·9	176?	49·1	13·4	65·6	62·0	31·1
88·9	88·0	18·0	10·9	27·2	25·9	4·1	22·9	26·1	191	47·2	11·8 (*R*)	63·3 (*R*)	62·1	30·0
89·1	90·0	19·0	9·0	29·9	29·0	5·8	27·0	31·0	198	43·8	15·5	64·4	55·2	35·5
82·0	84·5	17·1	11·9	34·5	25·2	6·0	19·7	24·0	188·5	43·0	12·0	56·1	54·2	30·8
88·8	88·8	19·4	10·0	30·0	—	7·0	—	—	201	45·6	13·1	65·4	56·1	—
93·8	91·2	22·9	14·0	28·9	27·8	3·1	25·1	26·8	210	52·8	15·5	71·7	67·1	34·9
80·9	85·3	17·8	9·0	28·6	26·0	6·0	24·6	28·1	192	43·1	16·1	67·2	52·4	34·0
82·4	81·0?	18·1	9·8	25·6	26·1	5·0	23·9	26·6	183·5	51·3	12·2	71·2	61·4	32·0
87·0	83·5	20·9	9·1	35·1	—	4·0	27·0?	30·9?	191·5	47·3	11·8	61·8	61·5	—
88·7	88·1	19·8	10·5	28·2	28·1	4·3	26·5	28·8	195	45·0	11·0	56·9	56·0	33·0
80·2	85·5	16·5 (*R*)	8·9 (*R*)	26·9	28·8	7·0	29·0	33·9	191	47·0	15·9	56·0	62·7	33·2
81·2	80·2	16·2	8·2	27·9	24·0	5·0	20·9	24·0	181·5	47·0	12·3	67·0	57·3	30·0
90·2	85·6	21·6	10·5	29·8	32·7	3·3	32·1	34·1	198	45·1	10·4	61·4	54·6	36·3
80·9	81·6	18·5	12·0	—	29·5	5·9	26·3	31·2	190·5	41·0	15·2	53·1	51·4	37·0
85·1	84·9	21·2	7·3	27·8	28·0	5·0	26·0	29·1	190	40·9	11·6	56·2	50·2	30·5
84·6	86·1	20·9	10·5	29·1	29·0	4·0	28·9?	31·1?	190	36·5	17·3 (*R*)	64·2 (*R*)	49·0	34·2
86·0	84·9	21·3	9·7	29·1	27·1	4·2	24·1	26·3	196	41·5	11·3	—	53·0	33·0
78·1	81·8	16·0?	—	28·4	30·0	4·2	30·0	32·9	181	39·0	12·3	57·1	47·4	33·5
88·1	86·3	19·0	7·9	29·6	26·0	5·1	23·9	28·0	196·5	40·4	14·5	62·6	47·9	32·8
93·0	89·5	—	8·5	27·4	26·1	5·2	24·1	27·0	204	51·0	—	—	64·9	31·0
83·5	85·2	16·7	6·8	—	24·0	4·0	24·1	26·0	191	45·2	9·3	57·1	55·0	32·8
85·0	84·1	20·1	9·0	28·0	27·0	8·1	25·1	30·0	191	43·1	13·5	65·0	53·0	36·1
79·0	80·0	17·5?	8·0	—	26·2	7·0	24·0	28·1	181	49·7	11·6	69·5	55·6	34·6
80·0	80·0	17·8	8·0	27·6	27·7	6·8	—	—	185·5	41·5	10·2 (*R*)	56·3 (*R*)	51·2	34·9
84·0	84·0	17·3 (*R*)	6·0 (*R*)	30·0	28·1	5·1	24·0	27·0	197·5	37·3	9·5 (*R*)	53·7	43·3	32·8
—	—	22·5 (*R*)	11·0	27·1	32·1	6·1	25·0	29·1	—	47·0 (*R*)	15·8 (*R*)	63·6	58·2	34·2
79·2	81·1	15·1	6·2	30·1	23·8	7·9	20·0	24·2	187	35·5	7·9	44·1	42·9	30·5
89·5	88·9	17·9	10·5	29·7	—	8·1	—	—	199·5	56·1	14·1	74·0	66·2	—
82·6	81·1	19·0	11·1	29·0	28·5	6·9	25·0	30·0	186	41·8	13·5	62·0	51·0	35·2
88·0	89·2	17·1	7·0	28·1	31·0	3·0	30·2	32·0	198	42·0	11·0	62·9	47·9	36·0
91·7	94·5	20·0	8·8	27·0?	32·0	3·5	29·9	31·1	209·5	48·2	13·8	65·0 (*R*)	66·0	25·2
87·7	89·1	20·9	11·0	24·9	26·1	5·2	25·2	27·9	200	40·1	13·8	58·1	51·6	29·5
91·8	90·4	19·0	9·2	33·0	32·0	4·0	31·9	29·9	206·5	43·9	14·2	64·9	55·1	32·0
80·4	80·4	15·0	7·1	28·1	29·9	2·1	24·0?	25·9?	186	33·9	12·2	53·8	41·0	31·6
—	—	17·0	7·8	24·8	27·5	5·1	25·9	29·9	—	39·6	13·4	59·2	53·0	34·8
—	—	—	—	24·9	21·1	5·9	20·0	24·2	—	39·3	—	54·8	—	29·8
77·9	80·1	17·9	8·6	28·1	26·0	3·9	23·1	25·0	177·5	41·1	15·2	63·2 (*R*)	48·2 (*R*)	33·3
84·0	82·0	19·1	10·5	26·5	26·5?	5·0	25·0	28·0	193·5	37·0	14·1	57·5	46·9	32·1

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$c_y h$	$d_1 h$	$m_2 h$	$p_1 h$	$c_p l$	rl	ml	$c_r h/ml$	$c_r c_r/ml$	$g_d g_o/c_p l$	rb'/rl	$c_y b/c_y l$	$g_d g_o/c_r c_r$	$c_y h/c_r h$	$ih'/c_r c_y$	$d_1 h/c_r h$	$M \angle$
52·0	27·1	23·2	24·0	72·0	57·2	101·0	60·4	89·7	—	60·5	37·2	—	85·2	38·7	44·4	124·5
49·8	37·3	—	—	77·0	58·1	109·9	49·2	90·1	110·4	44·8	47·3	86·0	92·1	46·7	68·9	127·0
54·6	31·5	—	—	71·2	61·2	102·0	60·2	100·0	123·7	49·5	47·6	86·2	88·9	42·6	51·3	122·0
42·8	32·1	—	30·6	63·8	56·7	99·9	54·8	86·3	123·2	52·9	43·1	91·2	78·2	37·2	58·7	132·9
46·4 (*R*)	29·8	20·8	25·1	73·0	—	99·2	53·5	—	131·5	—	43·2	—	87·4	—	56·1	125·9
49·9	31·6	23·8	28·2	66·3	62·3	105·0	62·5	94·2	155·1	46·5	43·6	103·9	76·1	42·7	48·2	132·3
58·6	36·8	—	31·3	75·6?	65·2?	106·0	59·9	86·7	—	51·1	—	—	92·3	44·9	58·0	—
59·8	29·8	22·0?	—	82·9	66·6	112·0	54·5	—	108·6	46·2	45·7	—	98·0	44·9	48·9	108·0
49·6	30·9	20·1	25·7	70·0	54·3	96·0	54·4	92·6	121·3	53·2	43·7	95·5	95·0	38·6	59·2	121·6
39·9?	31·5	14·9	25·0	72·3	46·7	97·9	52·4	101·1	118·9	60·4	41·5	86·9	77·8	41·9	61·4	125·9
38·9	30·2	19·2	25·2	65·9	48·4	97·4	54·2	91·3	122·9	53·9	60·4	91·1	73·7	34·7	57·2	133·4
60·2	35·0	24·2	28·0	76·1	66·1	106·2	59·5	93·2	136·5	41·8	—	104·9	95·3	42·5	55·4	122·4
56·5	30·1	22·2	26·0?	75·0	60·2	100·2	63·1	86·6	125·9	61·1	37·2	108·8	89·4	30·0	47·6	121·4
48·2	29·7	19·7	26·9	74·9	53·6	99·1	61·8	96·7	101·3	57·8	48·6	79·2	78·8	38·8	48·5	121·5
43·7	33·6	—	30·3	69·0	56·8	106·8	51·1	83·1	121·9	45·8	57·2	94·8	80·0	41·3	61·5	132·4
40·8	22·2	16·1	18·8	56·1	49·7	86·0	57·6	95·2	144·7	48·7	—	99·1	82·4	39·1	44·8	129·2
67·1 (*R*)	29·8?	26·9	26·9	77·3	73·3?	98·1	72·8	—	—	39·7	42·1	—	94·0	—	41·7	112·2
46·0	30·2	21·2	26·2	74·6	55·2	109·2	47·6	76·9	122·2	56·2	57·1	108·6	88·5	34·3	58·1	131·5
42·1	27·1	19·8	22·6	70·8	48·6	92·0	—	—	120·9	63·8	39·7	—	—	—	—	120·7
61·4	32·5	24·8	28·9	85·4	64·6	112·2	60·7	—	102·8	61·9	46·3	—	52·9	36·0	47·7	104·9
45·3	35·9	23·1?	28·0	72·6	55·1	106·2	53·9	84·3	105·8	48·1	53·1	85·8	79·2	40·4	62·8	133·9
56·9	41·0	27·2	32·9	76·1	58·4	97·1	65·8	108·1	139·3	52·1	41·8	100·0	89·0	37·7	64·2	130·0
52·0	28·9	23·1	26·3	75·8	58·9	106·1	57·7	88·0	115·2	54·0	53·3	93·5	85·0	49·1	47·2	125·9
51·3	31·0	22·1	26·0	74·2	54·0	95·1	59·1	92·4	125·3	55·0	51·6	105·8	91·3	39·1	55·2	116·4
53·2	37·5	27·3	—	75·0	62·1	107·1	60·2	—	110·7	54·8	52·9	—	82·5	—	58·1	124·9
52·0	26·0	18·9	21·0	69·5	55·1	92·2	59·8	94·5	121·6	55·4	52·4	97·0	94·4	32·7	47·2	119·5
56·8	28·0	25·0	23·8	72·0	59·2	92·7	61·6	96·1	127·1	57·6	48·7	102·7	99·5	35·7	49·0	112·9
47·2	28·0	22·9	23·9	66·3	53·9	90·0	61·8	98·3	130·2	46·8	40·0	97·5	84·9	37·7	50·4	122·0
40·3	23·7	21·0	25·0	69·1	49·2	99·4	55·4	88·5	123·3	62·6	50·9	96·8	73·1	38·5	43·0	131·4
62·0	31·1	26·0	28·9	66·8	70·2	105·9	61·9	87·8	131·9	42·7	58·4	94·7	94·5	41·7	47·4	126·0
62·1	30·0	22·8	26·2	73·8	64·8	95·0	66·6	—	145·7	45·1	60·6	—	98·1	33·4	47·4	113·0
55·2	35·5	25·8	29·6	78·2	62·9	109·0	59·1	86·3	139·4	50·9	47·4	115·8	85·7	47·3	55·1	125·3
54·2	30·8	21·6	23·7	73·2	60·4	101·3	55·4	—	124·0	46·4	69·6	—	96·6	36·5	54·9	123·9
56·1	—	23·8	26·3?	77·1	61·2	109·0	60·0	82·6	134·6	47·9	51·5	115·3	85·8	42·1	—	120·4
67·1	34·9	28·7	30·3	80·3	70·4	106·4	67·4	92·4	127·4	48·6	61·1	104·1	93·6	48·6	48·7	114·9
52·4	34·0	26·4	30·2	69·9	61·9	104·8	64·1	85·0	144·2	47·8	50·6	113·1	78·0	51·1	50·6	127·9
61·4	32·0	27·3	17·0	69·3	64·4	94·4	75·4	103·7	141·6	49·7	54·1	100·2	86·2	37·4	44·9	115·6
61·5	—	27·1	18·9	75·2	64·6	100·8	61·3	—	133·5	48·1	43·5	—	99·5	34·5	—	118·1
56·0	33·0	25·1	28·9	77·1	61·1	106·1	53·6	89·3	132·0	53·8	53·0	107·5	98·4	33·4	58·0	124·9
62·7	33·2	26·5	30·3	70·1	67·3	97·1	57·7	97·9	141·2	40·3	53·9	104·2	112·0	58·7	59·3	119·0
57·3	30·0	18·5	29·9	72·3	62·7	99·1	67·6	97·0	132·9	41·3	50·6	100·0	85·5	42·3	44·8	120·4
54·6	36·3	27·8	31·0	77·1	59·2	109·0	56·3	92·9	127·2	56·1	48·6	96·9	88·9	33·7	59·1	125·0
51·4	37·0	—	31·1	75·0	56·8	104·2	51·0	90·1	112·0	60·4	64·9	89·5	96·8	50·8	69·7	125·9
50·2	30·5	19·9	26·5	71·1	60·5	105·1	53·5	89·0	149·1	47·6	34·4	113·4	89·3	36·0	54·3	129·5
49·0	34·2	—	30·0	72·0	59·9	108·1	59·4	—	141·5	51·1	50·2	—	76·3	55·6	53·3	131·4
53·0	33·0	24·9	28·0?	77·2	57·6	105·0	—	—	108·0	54·9	45·5	—	—	—	—	121·9
47·4	33·5	27·0	30·2	67·1	63·3	108·9	52·4	81·8	141·7	42·8	—	106·7	83·0	42·3	58·7	136·5
47·9	32·8	25·2	27·3	77·2	57·1	108·5	57·7	88·8	112·6	54·3	41·6	90·2	76·5	40·3	52·4	126·7
64·9	31·0	25·0	25·8	82·1	68·1	105·2	—	—	121·7	51·5	—	—	—	—	—	113·4
55·0	32·8	—	—	76·4	60·1	100·1	57·0	99·2	121·6	56·1	40·7	93·6	96·3	31·0	57·4	110·4
53·0	36·1	25·8	31·5	72·9	60·1	105·1	61·9	89·3	138·5	55·1	44·8	107·6	81·5	42·3	55·5	126·0
55·6	34·6	—	30·8	70·0	63·3	103·0	67·5	87·5	135·9	42·8	45·7	105·5	80·0	38·7	49·8	125·1
51·2	34·9	23·5	28·4	72·9	58·1	99·1	56·8	—	114·8	49·9	44·9	—	90·9	39·1	62·0	123·4
43·3	32·8	20·1	24·6	78·4	49·5	101·8	52·8	—	99·4	66·5	34·7	—	80·6	—	61·1	123·5
58·2	34·2	25·2	27·7	—	—	—	—	—	—	—	48·9	—	91·5	51·1	53·8	—
42·9	30·5	23·2	27·5	72·8	54·8	108·1	40·8	81·4	118·8	51·1	41·1	98·3	97·3	26·3	69·2	135·8
66·2	—	29·1	32·7	78·1	69·9	104·9	70·5	92·7	137·0	46·6	58·7	110·1	89·5	46·7	—	115·7
51·0	35·2	26·0	27·0	69·8	59·8	103·2	60·2	88·3	134·7	51·5	58·4	103·2	82·3	45·6	56·8	128·4
47·9	36·0	20·2	29·2?	76·9	56·9	108·2	58·1	87·6	124·8	55·4	40·9	101·3	76·2	33·0	57·2	127·6
66·0	25·2	—	29·6	83·9	69·1	108·2	—	—	127·9	45·0	44·0	—	—	37·4	38·8	113·6
51·6	29·5	23·3	25·0	79·1	60·3	113·5	51·2	82·0	113·8	50·2	52·6	96·7	88·8	45·1	50·8	128·9
55·1	32·0	21·4	27·4	80·3	62·1	112·9	57·5	81·3	125·3	53·1	48·4	109·6	84·9	44·2	49·3	126·3
41·0	31·6	22·6	27·9	70·2	52·1	105·4	51·0	85·4	125·4	59·5	47·3	98·9	76·2	38·2	58·7	135·4
53·0	34·8	26·9	30·1	—	—	98·0	60·4	93·9	—	—	45·9	—	89·5	41·9	58·8	—
—	29·8	20·1	23·5	—	—	—	—	—	—	—	—	—	—	—	54·4	—
48·2 (*R*)	33·3	22·0	38·9	67·6	59·2?	101·0	62·6	—	136·1	45·3	48·2	—	76·3	45·4	52·7	131·1
46·9	32·1?	27·9	32·8	73·1	58·5	110·0	52·3	76·8	116·7	56·9	55·0	100·9	81·6	39·0	55·8	136·0

(EXCLUDING MANY INCOMPLETE).

Lengths and Heights on Board

$c_r h$	$c_p h$	$d_1 h$	$m_2 h$	$p_1 h$	$c_p l$	rl	ml	$c_r h/ml$	$c_r c_r/ml$	$g_d g_o/c_p l$
61·0	52·0	27·1	23·2	24·0	72·0	57·2	101·0	60·4	89·7	—
54·1	49·8	37·3	—	—	77·0	58·1	109·9	49·2	90·1	110·4
61·4	54·6	31·5	—	—	71·2	61·2	102·0	60·2	100·0	123·7
54·7	42·8	32·1	—	30·6	63·8	56·7	99·9	54·8	86·3	123·2
53·1	46·4 (*R*)	29·8	20·8	25·1	73·0	—	99·2	53·5	—	131·5
65·6	49·9	31·6	23·8	28·2	66·3	62·3	105·0	62·5	94·2	155·1
63·5	58·6	36·8	—	31·3	75·6?	65·2?	106·0	59·9	86·7	—
61·0	59·8	29·8	22·0?	—	82·9	66·6	112·0	54·5	—	108·6
52·2	49·6	30·9	20·1	25·7	70·0	54·3	96·0	54·4	92·6	121·3
51·3	39·9?	31·5	14·9	25·0	72·3	46·7	97·9	52·4	101·1	118·9
52·8	38·9	30·2	19·2	25·2	65·9	48·4	97·4	54·2	91·3	122·9
63·2	60·2	35·0	24·2	28·0	76·1	66·1	106·2	59·5	93·2	136·5
63·2	56·5	30·1	22·2	26·0?	75·0	60·2	100·2	63·1	86·6	125·9
61·2	48·2	29·7	19·7	26·9	74·9	53·6	99·1	61·8	96·7	101·3
54·6	43·7	33·6	—	30·3	69·0	56·8	106·8	51·1	83·1	121·9
49·5	40·8	22·2	16·1	18·8	56·1	49·7	86·0	57·6	95·2	144·7
71·4 (*R*)	67·1 (*R*)	29·8?	26·9	26·9	77·3	73·3?	98·1	72·8	—	—
52·0	46·0	30·2	21·2	26·2	74·6	55·2	109·2	47·6	76·9	122·2
—	42·1	27·1	19·8	22·6	70·8	48·6	92·0	—	—	120·9
68·1	61·4	32·5	24·8	28·9	85·4	64·6	112·2	60·7	—	102·8
57·2	45·3	35·9	23·1?	28·0	72·6	55·1	106·2	53·9	84·3	105·8
63·9	56·9	41·0	27·2	32·9	76·1	58·4	97·1	65·8	108·1	139·3
61·2	52·0	28·9	23·1	26·3	75·8	58·9	106·1	57·7	88·0	115·2
56·2	51·3	31·0	22·1	26·0	74·2	54·0	95·1	59·1	92·4	125·3
64·5?	53·2	37·5	27·3	—	75·0	62·1	107·1	60·2	—	110·7
55·1	52·0	26·0	18·9	21·0	69·5	55·1	92·2	59·8	94·5	121·6
57·1	56·8	28·0	25·0	23·8	72·0	59·2	92·7	61·6	96·1	127·1
55·6	47·2	28·0	22·9	23·9	66·3	53·9	90·0	61·8	98·3	130·2
55·1	40·3	23·7	21·0	25·0	69·1	49·2	99·4	55·4	88·5	123·3
65·6	62·0	31·1	26·0	28·9	66·8	70·2	105·9	61·9	87·8	131·9
63·3 (*R*)	62·1	30·0	22·8	26·2	73·8	64·8	95·0	66·6	—	145·7
64·4	55·2	35·5	25·8	29·6	78·2	62·9	109·0	59·1	86·3	139·4
56·1	54·2	30·8	21·6	23·7	73·2	60·4	101·3	55·4	—	124·0
65·4	56·1	—	23·8	26·3?	77·1	61·2	109·0	60·0	82·6	134·6
71·7	67·1	34·9	28·7	30·3	80·3	70·4	106·4	67·4	92·4	127·4
67·2	52·4	34·0	26·4	30·2	69·9	61·9	104·8	64·1	85·0	144·2
71·2	61·4	32·0	27·3	17·0	69·3	64·4	94·4	75·4	103·7	141·6
61·8	61·5	—	27·1	18·9	75·2	64·6	100·8	61·3	—	133·5
56·9	56·0	33·0	25·1	28·9	77·1	61·1	106·1	53·6	89·3	132·0
56·0	62·7	33·2	26·5	30·3	70·1	67·3	97·1	57·7	97·9	141·2
67·0	57·3	30·0	18·5	29·9	72·3	62·7	99·1	67·6	97·0	132·9
61·4	54·6	36·3	27·8	31·0	77·1	59·2	109·0	56·3	92·9	127·2
53·1	51·4	37·0	—	31·1	75·0	56·8	104·2	51·0	90·1	112·0
56·2	50·2	30·5	19·9	26·5	71·1	60·5	105·1	53·5	89·0	149·1
64·2 (*R*)	49·0	34·2	—	30·0	72·0	59·9	108·1	59·4	—	141·5
—	53·0	33·0	24·9	28·0?	77·2	57·6	105·0	—	—	108·0
57·1	47·4	33·5	27·0	30·2	67·1	63·3	108·9	52·4	81·8	141·7
62·6	47·9	32·8	25·2	27·3	77·2	57·1	108·5	57·7	88·8	112·6
—	64·9	31·0	25·0	25·8	82·1	68·1	105·2	—	—	121·7
57·1	55·0	32·8	—	—	76·4	60·1	100·1	57·0	99·2	121·6
65·0	53·0	36·1	25·8	31·5	72·9	60·1	105·1	61·9	89·3	138·5
69·5	55·6	34·6	—	30·8	70·0	63·3	103·0	67·5	87·5	135·9
56·3 (*R*)	51·2	34·9	23·5	28·4	72·9	58·1	99·1	56·8	—	114·8
53·7	43·3	32·8	20·1	24·6	78·4	49·5	101·8	52·8	—	99·4
63·6	58·2	34·2	25·2	27·7	—	—	—	—	—	—
44·1	42·9	30·5	23·2	27·5	72·8	54·8	108·1	40·8	81·4	118·8
74·0	66·2	—	29·1	32·7	78·1	69·9	104·9	70·5	92·7	137·0
62·0	51·0	35·2	26·0	27·0	69·8	59·8	103·2	60·2	88·3	134·7
62·9	47·9	36·0	20·2	29·2?	76·9	56·9	108·2	58·1	87·6	124·8
65·0 (*R*)	66·0	25·2	—	29·6	83·9	69·1	108·2	—	—	127·9
58·1	51·6	29·5	23·3	25·0	79·1	60·3	113·5	51·2	82·0	113·8
64·9	55·1	32·0	21·4	27·4	80·3	62·1	112·9	57·5	81·3	125·3
53·8	41·0	31·6	22·6	27·9	70·2	52·1	105·4	51·0	85·4	125·4
59·2	53·0	34·8	26·9	30·1	—	—	98·0	60·4	93·9	—
54·8	—	29·8	20·1	23·5	—	—	—	—	—	—
63·2 (*R*)	48·2 (*R*)	33·3	22·0	38·9	67·6	59·2?	101·0	62·6	—	136·1
57·5	46·9	32·1?	27·9	32·8	73·1	58·5	110·0	52·3	76·8	116·7

Indices								Angles (in degrees)				
ml	g_2g_0/c_yl	rb'/rl	c_yb/c_yl	g_2g_0/c_rc_r	c_yh/c_rh	ih'/c_rc_y	d_yh/c_rh	$M\angle$	$R\angle$	$G\angle$	$C\angle$	$C'\angle$
7	—	60·5	37·2	—	85·2	38·7	44·4	124·5	77·2	—	72·0	75·9
1	110·4	44·8	47·3	86·0	92·1	46·7	68·9	127·0	59·7	58·4	56·4	55·9
0	123·7	49·5	47·6	86·2	88·9	42·6	51·3	122·0	67·6	66·8	70·0	76·2
3	123·2	52·9	43·1	91·2	78·2	37·2	58·7	132·9	66·1	66·1	76·0	76·0
	131·5	—	43·2	—	87·4	—	56·1	125·9	—	68·2	55·5	57·6
2	155·1	46·5	43·6	103·9	76·1	42·7	48·2	132·3	77·7	79·8	60·1	60·5
7	—	51·1	—	—	92·3	44·9	58·0	—	—	—	60·0	60·2
	108·6	46·2	45·7	—	98·0	44·9	48·9	108·0	64·2	58·4	54·0	56·2
6	121·3	53·2	43·7	95·5	95·0	38·6	59·2	121·6	66·1	66·0	73·0	75·0
1	118·9	60·4	41·5	86·9	77·8	41·9	61·4	125·9	75·1	63·9	59·9	62·5
3	122·9	53·9	60·4	91·1	73·7	34·7	57·2	133·4	73·6	65·5	66·4	66·4
2	136·5	41·8	—	104·9	95·3	42·5	55·4	122·4	65·0	73·3	60·9	72·0
6	125·9	61·1	37·2	108·8	89·4	30·0	47·6	121·4	71·0	67·8	76·0	73·4
7	101·3	57·8	48·6	79·2	78·8	38·8	48·5	121·5	84·8	57·9	66·7	70·5
1	121·9	45·8	57·2	94·8	80·0	41·3	61·5	132·4	63·9	66·7	61·0	61·9
2	144·7	48·7	—	99·1	82·4	39·1	44·8	129·2	70·7	73·9	62·8	63·0
	—	39·7	42·1	—	94·0	—	41·7	112·2	—	—	60·0?	58·1
9	122·2	56·2	57·1	108·6	88·5	34·3	58·1	131·5	61·0	66·0	51·7	57·9
	120·9	63·8	39·7	—	—	—	—	120·7	74·7	64·4	60·1	61·7
	102·8	61·9	46·3	—	52·9	36·0	47·7	104·9	74·6	59·1	61·8	65·9
3	105·8	48·1	53·1	85·8	79·2	40·4	62·8	133·9	67·2	60·2	62·9	60·8
1	139·3	52·1	41·8	100·0	89·0	37·7	64·2	130·0	67·8	72·2	65·5	66·0
0	115·2	54·0	53·3	93·5	85·0	49·1	47·2	125·9	72·0	64·0	64·1	64·0
4	125·3	55·0	51·6	105·8	91·3	39·1	55·2	116·4	76·0	72·9	70·5	74·9
	110·7	54·8	52·9	—	82·5	—	58·1	124·9	73·9	61·4	74·9	77·9
5	121·6	55·4	52·4	97·0	94·4	32·7	47·2	119·5	65·6	68·8	69·8	72·8
1	127·1	57·6	48·7	102·7	99·5	35·7	49·0	112·9	127·6	67·5	74·5	78·9
3	130·2	46·8	40·0	97·5	84·9	37·7	50·4	122·0	73·1	70·8	74·0	72·1
5	123·3	62·6	50·9	96·8	73·1	38·5	43·0	131·4	73·6	68·0	—	65·5
8	131·9	42·7	58·4	94·7	94·5	41·7	47·4	126·0	61·2	68·8?	62·0	65·0
	145·7	45·1	60·6	—	98·1	33·4	47·4	113·0	67·3	84·3	70·1	72·0
3	139·4	50·9	47·4	115·8	85·7	47·3	55·1	125·3	73·5	75·0	58·5	63·0
	124·0	46·4	69·6	—	96·6	36·5	54·9	123·9	58·8	66·0	65·5	64·0
6	134·6	47·9	51·5	115·3	85·8	42·1	—	120·4	77·3	71·8	—	—
4	127·4	48·6	61·1	104·1	93·6	48·6	48·7	114·9	74·6	67·1	57·2	61·4
0	144·2	47·8	50·6	113·1	78·0	51·1	50·6	127·9	79·7	74·7	57·8	59·0
7	141·6	49·7	54·1	100·2	86·2	37·4	44·9	115·6	83·2	73·0	62·8	69·0
	133·5	48·1	43·5	—	99·5	34·5	—	118·1	62·3	72·2	—	74·5
3	132·0	53·8	53·0	107·5	98·4	33·4	58·0	124·9	58·6	70·5	60·6	61·8
9	141·2	40·3	53·9	104·?	112·0	58·7	59·3	119·0	69·6	73·3	63·9	66·6
0	132·9	41·3	50·6	100·0	85·5	42·3	44·8	120·4	78·7	73·0	60·0	61·9
9	127·2	56·1	48·6	96·9	88·9	33·7	59·1	125·0	70·7	67·9	68·1	70·7
1	112·0	60·4	64·9	89·5	96·8	50·8	69·7	125·9	80·0	62·4	71·8	76·8
0	149·1	47·6	34·4	113·4	89·3	36·0	54·3	129·5	60·6	77·1	61·0	64·1
	141·5	51·1	50·2	—	76·3	55·6	53·3	131·4	75·7	65·1	70·0	72·5
	108·0	54·9	45·5	—	—	—	—	121·9	52·7	58·2	65·8	66·3
8	141·7	42·8	—	106·7	83·0	42·3	58·7	136·5	63·1	73·0	62·0	62·1
8	112·6	54·3	41·6	90·2	76·5	40·3	52·4	126·7	73·3	59·8	67·5	69·9
	121·7	51·5	—	—	—	—	—	113·4	—	65·8	71·1	72·8
2	121·6	56·1	40·7	93·6	96·3	31·0	57·4	116·4	67·6	66·8	70·9	72·8
3	138·5	55·1	44·8	107·6	81·5	42·3	55·5	126·6	77·2	73·2	67·4	69·0
5	135·9	42·8	45·7	105·5	80·0	38·7	49·8	125·1	78·2	73·8	58·7	58·0
	114·8	49·9	44·9	—	90·9	39·1	62·0	123·4	68·8	63·0	73·0	66·0
	99·4	66·5	34·7	—	80·6	—	61·1	123·5	83·3	55·1	65·8	68·8
	—	—	48·9	—	91·5	51·1	53·8	—	—	—	56·1	59·0
4	118·8	51·1	41·1	98·3	97·3	26·3	69·2	135·8	46·9	66·0	46·9	51·2
7	137·0	46·6	58·7	110·1	89·5	46·7	—	115·7	78·4	73·3	—	—
3	134·7	51·5	58·4	103·2	82·3	45·6	56·8	128·4	74·3	70·0	62·0	68·7
6	124·8	55·4	40·9	101·3	76·2	33·0	57·2	127·6	80·7	65·4	70·0	73·9
	127·9	45·0	44·0	—	—	37·4	38·8	113·6	62·8	70·2	61·8	65·1
0	113·8	50·2	52·6	96·7	88·8	45·1	50·8	128·9	64·5	63·0	48·6	51·4
3	125·3	53·1	48·4	109·6	84·9	44·2	49·3	126·3	75·6	67·0	47·9	51·0
4	125·4	59·5	47·3	98·9	76·2	38·2	58·7	135·4	67·6	66·0	67·7	66·9
9	—	—	45·9	—	89·5	41·9	58·8	—	—	—	75·5	79·7
	—	—	—	—	—	—	54·4	—	—	—	69·0	76·8
	136·1	45·3	48·2	—	76·3	45·4	52·7	131·1	71·1	70·9	62·0	68·4
8	116·7	56·9	55·0	100·9	81·6	39·0	55·8	136·0	63·7	61·9	—	62·8

To find the predecessors of our type we must go back to the early invaders of this country, the people of the Iron Age period, rather than to the Anglo-Saxons*. A discussion of these relationships is given elsewhere in the present issue of *Biometrika*.

I should like here to acknowledge my thanks to Mr E. S. Pearson for photographing the crania.

DESCRIPTION OF PLATES.

Plate I.	*FA* 44.	Wormian bone (? Ossicle of Asterion).
,, II.	*FA* 89.	Styliform process on temporal squama.
,, III.	*FA* 136.	Lower occipital flattening.
,, IV.	*FA* 114.	Partially healed injury on right frontal bone.
,, V.	*FA* 264.	Transverse occipital groove.
,, VI (*a*).	*FA* 1.	Anomalous process on Pterygoid plate.
,, VI (*b*).	*FA* 88.	Porus crotaphitico-buccinatorius divided into two externally.

[* Professor F. G. Parsons at the Cardiff Meeting of the British Association asserted that Macdonell's association of the Whitechapel crania with the Long Barrow crania of Schuster was wholly unjustifiable. He has since stressed the point again in a paper in the *Journal of the Royal Anthropological Institute*, Vol. LI. p. 55 *et seq.* No reply was possible until a series of Anglo-Saxon crania had been measured by biometric workers. The following series of Coefficients of Racial Likeness will speak for themselves:

Whitechapel and Schuster's Long Barrow	3·71 ± ·18 (28).
Farringdon Street and Schuster's Long Barrow	5·28 ± ·18 (27).
Farringdon Street and Whitechapel from Table I ...	4·15 ± ·18 (27).
Anglo-Saxon and Farringdon Street	5·27 ± ·18 (30).
Anglo-Saxon and Whitechapel	2·98 ± ·18 (27).
Anglo-Saxon and Moorfields	4·88 ± ·20 (25).
Anglo-Saxon and Parsons' Hythe crania	72·53 ± ·32 (8).
Anglo-Saxon and Parsons' Rothwell crania	10·33 ± ·32 (8).

From these results it appears that whatever the Hythe and Rothwell crania represent their measurements are not Anglo-Saxon, and that the Whitechapel and Schuster's Long Barrow skulls are as near to each other as the Anglo-Saxons to Farringdon Street, Whitechapel and Moorfields crania or indeed as the Whitechapel to the Farringdon Street crania. The general result seems to be that Schuster's series (Mean C.R.L. = 4·49) is as closely related as the Anglo-Saxons (Mean C.R.L. = 4·37) to the Londoners measured in the Biometric Laboratory. Where to place the Hythe and Rothwell crania measured by Professor Parsons, it is impossible to say. ED.]

A FIRST STUDY OF THE CRANIOLOGY OF ENGLAND AND SCOTLAND FROM NEOLITHIC TO EARLY HISTORIC TIMES, WITH SPECIAL REFERENCE TO THE ANGLO-SAXON SKULLS IN LONDON MUSEUMS.

By G. M. MORANT, M.Sc.

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(1) *Introduction.*

The material available for a biometric study of British ethnology is miserably scanty. From the early papers of Macdonell and the recent one of Hooke on the skull, and the classical memoir of Pearson and Bell on the femur, the physical type of 17th century Londoners is sufficiently well known, but data for earlier periods and other localities are, for statistical purposes, almost wholly inadequate. The present paper partly fills that gap by providing full individual measurements and type contours of all the Anglo-Saxon skulls in the British Museum (Natural History), the Museum of the Royal College of Surgeons and the London Museum. The writer acknowledges his great indebtedness to the curators of those collections for freely giving him permission to study the material in their charge. An attempt has also been made to compile the mean measurements of racial types extant in Britain in earlier periods, but, in most cases, both the number of measurements provided and the number of skulls dealt with are too few to provide a definitive determination of the single types. The present study, then, is essentially nothing more than a first contribution. For no single one of the populations dealt with is the material plentiful enough to furnish more than crude first approximations to the statistical constants. The method of the Coefficient of Racial Likeness,

first suggested by Professor Karl Pearson*, has been found an indispensable aid. To all the populations dealt with the following conditions were applied:

(*a*) That the distributions of characters were fitted reasonably well by normal curves;

(*b*) That the sexual differences between the ♂ and ♀ mean measurements were of the same order as those of a standard population; and

(*c*) That the standard deviations of characters were of the same order as those of that population.

The standard population with which comparison has been made is that of the long series of 17th century skulls found in a single pit in Whitechapel and now preserved in the Biometric Laboratory. They were sexed by Sir George Thane and Professor Pearson and fulfilled all the statistical conditions demanded from a homogeneous population.

The following are the main conclusions which the available material suggests, but they may be substantially modified by later and more comprehensive studies.

(i) The population of England and Scotland in late Neolithic times was racially homogeneous. The skull has a peculiarly great length, a low cephalic index and an average height.

(ii) The invading Bronze Age people were of a markedly contrasted brachycephalic type and the English and Scottish populations of that period known to us are similar, but not identical. Some skulls of the pure Neolithic type have been found associated with the typical Bronze Age artifacts, and there appears to have been a certain amount of intermixture between the two races, but the invading one easily predominated. The earlier type was probably extinct before the end of the Bronze Age.

(iii) An entirely different form of skull is found in Iron Age settlements. It is just dolichocephalic and is above all characterised by its low calvarial height. Crania of that type, representing a homogeneous population, have been found in numerous scattered English sites and in the Lowlands of Scotland, and there was apparently no modification of that population until at least as late as the close of the Roman era. For the Iron Age period there are no recorded skeletal remains which conform to the type of one or other of the two earlier peoples, so we assume that the latter were either entirely exterminated or that remnants of them sought refuge in the more inaccessible parts of the country.

(iv) All the Anglo-Saxon skulls dealt with in this paper can be dated between the 5th and early 10th centuries. They, again, form a perfectly homogeneous population, and the type is clearly distinguished from that of the British Iron Age by its greater calvarial height, though the lengths, breadths and cephalic indices of the two are almost identical. The ♀ Anglo-Saxon skulls are of precisely the same types as the ♂, suggesting that the earlier and later invaders lived side by side without intermixture for some centuries. From other evidence we know that the former were not exterminated, but that they were, in all probability, far more numerous than the Anglo-Saxons during that period.

* See *Biometrika*, Vol. xvi. 1924, pp. 11—14.

The question of the relationships of these four racial types to those of the populations found in Britain in later historic times is discussed in another paper in this issue.

(2) *English and Scottish Skulls of Neolithic and Bronze Age Date.*

It is now generally recognised that no enquiry into the origin of the present day populations of England and Wales can be complete which does not take cognisance of the races that occupied the countries in late prehistoric times. The extent, if any, to which those earlier populations have participated in the make-up of existing types is a matter which has frequently been discussed without leading to any unanimity of opinion and the lack of agreement has evidently been due to a large extent to a lack of adequate descriptions of sufficiently large numbers of the skeletal remains of the people concerned. The accumulation of archaeological evidence within the last hundred years has resulted in a reliable classification of the sequences of culture that followed Palaeolithic times. The vast majority of the late prehistoric skulls found in England were interred in tumuli which are generally classified as either long or round barrows. In early Neolithic times the dead were not covered by tumuli and few human remains of that period have been preserved. The long barrows are the characteristic erections of the late Neolithic period. In general they are found in isolated positions—being in that respect unlike the Bronze Age barrows which were almost invariably grouped in cemeteries—and the majority of them appear to be analogous to family vaults. It is usual to find in the central chamber the bodies of a number of people who did not die at the same time. Inhumation was the invariable form of disposal of the dead. The different varieties in structure of these long barrows are not generally supposed to have any chronological or racial significance. The stone chambered tumuli found plentifully in Gloucestershire and North Wiltshire are not essentially different from the unchambered barrows of Yorkshire and Derbyshire; the different form in the south being merely occasioned, it is supposed, by the presence of suitable large blocks of stone. Towards the end of the Neolithic period an alien race invaded England, arriving on the east coast and gradually spreading westwards. Their artifacts and funerary customs were distinctly different from those of the autochthonous population. The invaders covered their dead with round barrows which are found clustered together in graveyards. Each mound was intended to cover a single body. Cremation was common. Either on their first appearance in this country or very shortly afterwards, the alien people introduced bronze and a characteristic pottery of the so-called "beaker" type. These Bronze Age people buried more objects with their dead than the Neolithic people they supplanted, but a number of round barrows have been found containing no artifacts and hence it is impossible to arrange the available skeletal material in any approach to a chronological sequence. As early as 1863 Thurnam (2, p. 158) made the statement: "Long barrows, long skulls; round barrows, round or short skulls," and our present purpose is to test the truth of that statement in the light of all the available material; to isolate the racial types represented and to obtain, if possible, the mean cranial measurements of the homogeneous components.

In the earlier descriptions of the contents of barrows the use of the terms primary and secondary interments often led to a slight confusion. Following Windle (1), the term "primary interment" will be used in the present paper to designate all burials of the same class although they may not be absolutely contemporaneous, while burials in the same barrow but of a different class will be called "alien interments." Thus, in general, the primary interment in a long barrow consists of several bodies buried at different times, though probably all within a comparatively few years, while the primary interment in a round barrow is a single body.

Measurements of skulls of Neolithic Age found in England have been given by the following writers: Thurnam (2 and 3), Davis and Thurnam* (4, Tables I and II), Rolleston (5), Schuster (6, Table I), Pitt-Rivers (8 and 9), Garson (10 and 11) and Keith (7). From these sources all skulls were selected which were undoubtedly primary interments in Neolithic long barrows and great care was taken to exclude all that were alien, or possibly alien, interments in such barrows. All accepted were barrow skulls, except those described by the last writer, which had been found in a megalithic monument at Coldrum in Kent, which was possibly of early Neolithic date. The others would, according to the general accepted chronology, be late Neolithic. Schuster (6, Table I) has given measurements of 37 long barrow skulls contained in the Museum of Anatomy at Oxford. One of them (No. 3) appears to be that described by Canon Greenwell (5, p. 485) as an alien interment, and 12 from a long barrow at Crawley in Oxfordshire are certainly not Neolithic. Bronze artifacts were found with the primary interments (see Ackerman, *Archaeologia*, Vol. XXXVII. p. 432, 1857). The mean cephalic index of the Crawley skulls is 79·3. The long barrow is probably of Bronze Age date, its occurrence in that period being quite exceptional.

The geographical distribution of the available 144 skulls of Neolithic Age is: Wiltshire 48, Gloucestershire 25, Dorsetshire 5, Staffordshire 47, Derbyshire 3, Yorkshire 9, Kent 7. Neolithic long barrows have also been found in small numbers in Somersetshire, Hampshire, Oxfordshire, Westmorland, Cumberland and Durham, but no measurements at all of skulls from those counties appear to have been given. The settled habitations of the people were only scattered over a relatively small part of the whole of England. Unfortunately very few measurements have been given even for the majority of the skulls described, and many have to be rejected because they are insufficiently defined. The standard deviations of all the ♂ skulls available are:

	F†	*B*	100 *B*/*F*	*U*
Standard Deviation	6·50 ± ·34	4·85 ± ·25	3·07 ± ·16	14·16 ± ·82
Number of Skulls	85	85	80	67

* Measurements of several of the Neolithic skulls in the *Crania Britannica* had previously been given by Thurnam (2).

† The letters used to indicate skull measurements in this paper are identical with those given by Miss Hooke in her memoir in this issue of *Biometrika*, see pp. 15—16.

Judged by these characters, the variability of the Neolithic English population is no greater than that of the Whitechapel English series of 17th century Londoners (cf. Table XIV), so we may provisionally assume that it is racially homogeneous.

The evidence relating to the earliest remains of man in Scotland has been comprehensively dealt with by Sir William Turner (12). The suggested evidences of Palaeolithic man's habitation in that country, earlier than Azilian times, have not been universally accepted, but remains of Neolithic date have been found widely dispersed and as far north as Caithness and the Orkney Islands. The culture of the more northernly people was not identical with that of the contemporary English population, but the differences were apparently only occasioned by local conditions, and, from such evidence, we have no reason to believe that the peoples in the two countries were not of the same race. Turner (12) gives measurements of 10 Neolithic skulls in Table I, and 2 in Table VI. Two other skulls (Skerrabrae) had previously been dealt with by Garson (13)*. The geographical distribution of these crania is: Caithness 1, Orkney Islands 4, Argyll 2, Arran 5†, Fife 1 and Midlothian 1. It is a noteworthy fact that all were found close to the sea.

Considering the ♂ series, we find Coefficients of Racial Likeness between the English (20·4) and Scottish (7·1) Neolithic populations of $-0{\cdot}12 \pm {\cdot}23$ for 16 characters and $-0{\cdot}44 \pm {\cdot}52$ for 3 indices‡. Low C.R.L.'s are to be expected when such small numbers are being dealt with, but in this case we may feel tolerably certain that the two samples represent the same race §. Combining the two series we have a population with the following standard deviations and it will be seen that the addition of the Scottish skulls does not sensibly affect the variability of the English group.

	F	*B*	100 *B*/*F*	*U*
Standard Deviation	$6{\cdot}28 \pm {\cdot}32$	$4{\cdot}90 \pm {\cdot}23$	$3{\cdot}22 \pm {\cdot}17$	$14{\cdot}46 \pm {\cdot}79$
Number of Skulls	88	97	83	75

* The skeletons discovered by Laing in Caithness and described by Huxley (14) were thought at that time to be of Neolithic date but they are now attributed to a later period.

† Some measurements of these 5 Neolithic skulls from Arran had been given by Bryce (23) before Turner (12).

‡ The following are the more reliable ♂ mean measurements that can be compared:

	100 *B*/*L*	*L*	*B*	*B'*	*S*	*U*	*H'*	*NB*	O_2
English skulls of Neolithic date	71·7 (17)	193·3 (17)	138·6 (86)	98·6 (13)	395·6 (33)	536·7 (67)	133·5 (7)	23·0 (12)	32 5 (10)
Scottish skulls of Neolithic date	72·7 (11)	192·7 (11)	140·1 (11)	98·6 (7)	381·7 (6)	535·0 (8)	134·4 (6)	23·3 (7)	32·7 (7)

§ In calculating all the Coefficients of Racial Likeness given in the present paper, the standard deviations of the long Egyptian E series (*Biometrika*, Vol. XVI. 1924, p. 338) were used. They are nearly all smaller than those of the Whitechapel English and of the Farringdon Street English, so the C.R.L.'s are probably rather greater than they ought to be. The Farringdon Street standard deviations could now be more appropriately used when dealing with British material.

Fitting the combined English and Scottish distributions of characters for Neolithic skulls with normal curves gives for goodness of fit:

	F	B	$100\,B/F$
Probability P ...	·513	·870	·541
Number of Groups*	11	9	8
Number of Skulls	88	97	83

Judging from the statistical constants derived from the distributions of skull measurements, we are justified in concluding that a single homogeneous race inhabited England and Scotland in late Neolithic times.

Owing to the common practice of cremation, the number of measured Bronze Age English skulls is hardly greater than that of those of Neolithic date, although round barrows are far more numerous than long barrows. The sources for the later period are: Schuster (6, Tables II, III and IV), Wright (15), Thurnam (2, Tables I and II, and 3, Tables I and II), Davis and Thurnam (4, Tables I and II), Pitt-Rivers (9, Tables following pp. 26 and 50), Garson (11, Wor Barrow and Handley Hill barrows other than Wor Barrow), Horton-Smith (16, Table II), Garson (17, Table facing p. 20), and Rolleston (5 and 18, Vol. I. p. 453). The skulls which could safely be considered to be of Bronze Age date were:

(1) primary interments in Bronze Age round barrows, possibly not associated with bronze or pottery,

(2) alien interments in long barrows associated with Bronze Age artifacts, and

(3) a few other interments associated with Bronze Age artifacts, and not covered by barrows.

In collecting the measurements all specimens of doubtful age were excluded and no attention was paid to cranial characters. By far the greater number of specimens had been found as primary interments in round barrows. The geographical distribution of the skulls selected in this way is: Yorkshire 157, Derbyshire 44, Wiltshire 34, Staffordshire 13, Dorsetshire 4, Gloucestershire 4, Northumberland 2, Cumberland 1 and Westmorland 1. As in earlier times, the forests of the Midlands and of the Weald of Surrey, Sussex and Kent appear to have been unpopulated. The three main centres of population in both Neolithic and Bronze Age times were Wiltshire and Gloucestershire in the south, Yorkshire in the north and Derbyshire and Staffordshire†. It is clear that all the skulls of Bronze Age date

* When possible it is well to divide a distribution into about 20 groups when testing the goodness of fit of a curve, but in the present case a smaller number had to be taken as many measurements had been given in tenths of inches, which led to an artificial grouping when they were converted into mm. With a small population the values of P may vary considerably according as the limits of the groups are changed. The values given above are higher than for some other groupings that were tried, but it is quite possible that they could be raised still more by re-adjusting the limits.

† They correspond closely with the districts where "beakers" have been found most plentifully (see Abercromby's map in *Journal of the Royal Anthropological Institute*, Vol. XXXII. 1902, facing p. 396).

do not belong to the same race. The standard deviations of the distributions of characters for ♂ skulls are:

	F	*B*	100 *B*/*F*	*U*	*G'H*
Bronze Age { Standard Deviation	7·17 ± ·28	7·48 ± ·32	5·42 ± ·21	15·79 ± ·62	4·02 ± ·26
Bronze Age { No. of Skulls ...	148	156	151	146	56
$\frac{\text{Bronze Age } \sigma}{\text{Whitechapel English } \sigma}$	1·162 ± ·061	1·417 ± ·043	1·663 ± ·077	1·051 ± ·053	1·041 ± ·089

The Bronze Age population was undoubtedly not homogeneous and Thurnam's dictum, "Round barrows, round skulls," cannot be accepted without some qualification. As a working hypothesis we may assume that not more than two pure racial elements were concerned in the make-up of the population found associated with objects of Bronze Age date in England. Thus that population will, in all probability, comprise:

(1) a pure Neolithic type element,

(2) a pure Bronze Age type element representing the invading race that introduced bronze and the "beaker" pottery into England, and

(3) a hybrid population resulting from the crossing of (1) and (2).

It is generally supposed that the groups (1) and (3) were small in proportion to (2). Our present purpose is to separate the three groups, if possible, by disintegrating the available distributions of cranial measurements. From the values of the standard deviations it would appear that the pure Neolithic and the pure Bronze Age types differ hardly at all for the characters *U* and *G'H*; the mean lengths (*F*) must be rather more distinctive, but it is between the breadths and the cephalic indices (100 *B*/*F*) that we may expect to find the most significant differences. The splitting up of the distribution of those indices—shown in Table I—is most likely to give satisfactory results.

TABLE I.

Distribution of the Cephalic Indices (100 *B*/*F*) *of Male Bronze Age English Skulls.*

100 *B*/*F*	64·5—66·5	66·5—68·5	68·5—70·5	70·5—72·5	72·5—74·5	74·5—76·5	76·5—78·5	78·5—80·5	80·5—82·5	82·5—84·5	84·5—86·5	86·5—88·5	88·5—90·5	90·5—92·5	Total
Frequency	1	4·5	6	8·5	15	14	20·5	21·5	23	12	12	10	2	1	151

The range of the cephalic indices in Table I is almost as great as for all modern races of man. For the constants of the postulated pure Neolithic component of the distribution we may accept the values found for the homogeneous population of English and Scottish skulls of Neolithic date. The mean index was found to be

71·3 and the standard deviation 3·223. Of the skulls of Bronze Age date there are 15 with an index less than 71·3 and provisionally we may make the assumptions: (1) that those 15 skulls are all of pure Neolithic type*, and (2) that in all there are 30 of the Bronze Age skulls of pure Neolithic type. By accepting the constants previously found and supposing that the population is normally distributed, we can now find the distribution of the cephalic indices of those 30 skulls and subtract it from the distribution in Table I. The standard deviation of the remainder is $4{\cdot}23 \pm {\cdot}18$ and that value is higher than that of a homogeneous population owing, as we suppose, to the presence of a small hybrid element added to the pure Bronze Age type. To separate the two we may consider the form of the right end of the curve. Assuming that all skulls with a cephalic index greater than 80·5 are of pure Bronze Age type, we may determine the constants of the normally distributed population of which the distribution to the right of 80·5 is a truncated portion†. The tail is found to represent more than half of a normal curve having a mean of 82·086, a standard deviation of 3·8136 and a total population of 91 individuals. The S.D. is rather higher than that of a homogeneous population, but we may reasonably accept it. This rough analysis of the distribution of the cephalic indices of 151 skulls of Bronze Age date has led to the conclusion that 30 of them are of pure Neolithic type, 91 of pure Bronze Age type and 30 of hybrid descent. A similar treatment applied to the distributions of B and F leads to no reasonable results owing, evidently, to the greater overlapping of the component curves. We shall adopt the divisions given by the cephalic indices. In doing this we are accepting as correct a statement which may be no more than a rough approximation to the truth, but it is well to remember that a statistical analysis of the data would seem to give quite the most reasonable solution of the problem and that no partitioning of a population by statistical methods can give more than a first approximation when the total number of individuals is no greater than 150. It is only our good fortune in finding a character as greatly contrasted for the two types as the mean cephalic indices are that makes such a method of approach possible. It will be shown later that the procedure leads to results which are in every way reasonable when tested by other methods.

Supposing that the total number of skulls in each of the three component groups of the Bronze Age date population to be known, some method of determining to which group each particular skull belongs is yet required before the mean measurements can be found. That distributing of the single skulls was carried out in the following manner. There are only 6 characters (viz. F, B, J, U, S and $100\,B/F$) which are available for all, or nearly all, the skulls dealt with, and the Neolithic means for those characters may be considered known. Taking each of the Bronze Age date skulls in turn, the differences of its 6 measurements, or as many of the 6 as were available, from the mean Neolithic values were divided by

* The following consideration provides some justification for this assumption. For the 15 skulls of Bronze Age date with cephalic indices less than 71·3 the mean B is 134·6 and the mean F is 196·0. For 43 skulls of Neolithic date with indices less than 71·3 the corresponding means are 135·8 and 196·9.

† By the method of Table XI in *Tables for Statisticians and Biometricians* (1914).

the standard deviations* of the characters and the mean of these quantities irrespective of sign—λ say—was calculated. The value of λ is a rough measure of the resemblance of the skull to the mean Neolithic type. Of the skulls for which the index $100\,B/F$ is given we have already considered all having values less than 71·3 to be of the pure Neolithic type. Apart from these there are 15 with values of λ less than 0·90 and of the skulls for which the cephalic index is not given there are 5 with values of λ less than 0·90. So in all there are 35 Bronze Age skulls which may be supposed to conform to the unhybridised Neolithic type. There are 31 individuals having cephalic indices and values of λ greater than 0·89 and less than 1·31 and 6 others with values of λ between the same limits for which $100\,B/F$ is not given. Those 37 may be taken to belong to a hybridised population resulting from the crossing of the two pure types†. All other Bronze Age date skulls are supposed to be of the pure Bronze Age type.

Sir William Turner (12, Tables II, IV and V) has collected together the measurements of a considerable number of Scottish Bronze Age skulls. Very few tumuli precisely similar to the round barrows of England have been found in Scotland. The usual form of burial there in the Bronze Age was in short cists covered by cairns or tumuli, or often unmarked by any mound. But the funerary customs were in other respects very similar and similar artifacts are found in the two countries. In both, inhumation—always with the body in a contracted position—and cremation were practised and each grave was prepared for the reception of a single individual. Measurements of Scottish Bronze Age skulls other than those dealt with by Sir William Turner are given by Barnard Davis (19, pp. 10 to 13), Davis and Thurnam (4, Table II), Busk (21), Garson (22) and Bryce (23). The total number of ♂ and ♀ skulls is 56. Bronze Age interments have been found in all parts of Scotland, though they are far more plentiful on the east side than the west. The distribution of the measured skulls is: Orkneys 18, North-East (Caithness, Sutherlandshire, Elgin, Banff and Aberdeen) 24, South-East (Lothians, Roxburgh and Berwick) 16, North-West (Ross) 1, Hebrides (Bernera and Benbecula) 2, South-West (Lanark and Ayr) 2, Central (Perth and Forfarshire) 4, and Arran 2. We may expect to find a few Scottish Bronze Age skulls of pure Neolithic type. Considering the ♂ skulls only, there are none with a cephalic index less than 71·3. Applying the method of analysis which was used to distinguish the various types among the English Bronze Age skulls, we find only 4 which may be supposed pure Neolithic (λ less than 0·90), 3 of hybrid descent (λ greater than 0·89 and less than 1·31) and 31 of pure Bronze Age type. But it must not be assumed that the latter represent identically the same population as the English Bronze Age type skulls.

Having disintegrated the Bronze Age date populations of England and Scotland, though by a method which is admittedly crude, it will be well to check, as far as possible, the accuracy of the results. A certain number of skulls were selected

* The standard deviations used in computing the Coefficients of Racial Likeness were used for this purpose, i.e. those of the long Egyptian E series (*Biometrika*, Vol. xvi. 1924, p. 338).

† Geographically the accepted pure Neolithic and hybrid groups of skulls seem to be randomly selected from the total Bronze Age date population.

which could be considered identically the same in type as the homogeneous population that inhabited England and Scotland in late Neolithic times. From the method of selection it follows that there will be a close similarity for the characters *F*, *B*, *J*, *U*, *S* and 100 *B*/*F*. If the process has performed what it was intended to, then the similarity of all other cranial characters should be as close as for those six. Between the English and Scottish Neolithic data means (30·7) and the supposed Neolithic skulls of the Bronze Age (15·6), C.R.L.'s are found of 0·23 ± ·21 for 20 characters and 0·50 ± ·36 for 6 indices and angles and as neither of those coefficients differs significantly from zero we have sufficient statistical justification for considering that the two samples represent the same population. A significant difference is not shown for any single character. The pooled means of the two series are given in column 2 of Table XII. The standard deviations of that population are in column 3 of Table XIV.

Fitting the distributions of characters with normal curves gives for goodness of fit:

	F	*B*	100 *B*/*F*
Probability *P* ...	·716	·309	·600
Number of Groups	9	8	8
Number of Skulls	116	128	116

If these constants are compared with those of the Neolithic date population it will be seen that with one exception—the goodness of fit for the breadth *B*—they are not significantly changed, so the addition of the Bronze Age skulls has not sensibly affected the homogeneity of the population. The means of the British Neolithic race that we have finally arrived at are unfortunately only reliable for a few characters and the majority of them are based on small numbers of crania. The type is distinguished from that of almost all modern races by its great length and low cephalic index. The counterpart of its other single characters can readily be found though the small nasal breadth and low nasal index are rather distinctive.

We may suppose that the majority of the skulls of Bronze Age date that have been found in England represent the racial type of the people who invaded the country at the beginning of that epoch—the pure Bronze Age type. The distributions of characters of the ♂ skulls that have been distinguished conform to the type of the normal curve.

	F	*B*	100 *B*/*F*
Probability *P* ...	·923	·757	·951
Number of Groups	8	9	8
Number of Skulls	90	89	89

The standard deviations of characters (Table XIV) are, with the exception of that of the skull breadth (*B*), not significantly greater than those of the Whitechapel

English population, and for B the difference is only just significant. It is reasonable to accept the population we have separated from the total available English skulls of Bronze Age date as representing a homogeneous race. That brachycephalic type (32·6) is widely different from the type of the Neolithic people (38·0). Between the two series of means the extraordinarily high C.R.L.'s of 56·55 ± ·18 for 26 characters and 91·93 ± ·30 for 9 indices and angles are found, and yet comparatively few characters show markedly significant differences. It must be remembered that for both populations the means of the calvarial characters in general—and in particular F, B, U and 100 B/F—are based on fairly large numbers of crania while the facial measurements are poorly represented. For that reason alone the former are more likely to show markedly significant differences than the latter. Values of α* greater than 5 are given in Table V. All the greatest differences between the Neolithic and English Bronze Age types are associated with the marked differences between the lengths and breadths of the brain-box; the latter type being shorter and at the same time much broader than the former. In spite of those differences the forehead breadths, nasio-basion lengths, and basio-bregmatic heights are practically identical for the two types. The only facial direct measurement which is differentiated is the nasal breadth, the small Neolithic value of that character being distinctive among European races. With more ample material we might be able to distinguish more significant differences, but it is at least surprising to find that two forms of cranium which differ so profoundly in some ways should show a close similarity for the greater number of characters. In spite of the large difference when compared with the British Neolithic skull, the distinguishing feature of the English Bronze Age type is its considerable length associated with brachycephaly. Hardly any other modern or prehistoric European race has a skull length greater than 184 mm. and a cephalic index greater than 80.

We cannot suppose that the samples of the English Bronze Age male type (33·6) and the Scottish Bronze Age male type (21·8) were drawn from identically the same population as Coefficients of Racial Likeness are found of 2·88 ± ·20 for 21 characters and 3·70 ± ·33 for 7 indices and angles. Significant differences (cf. the mean measurements given in Table XII) are shown by the characters 100 H'/L, U, LB and 100 B/L. The two are quite similar variants of the same racial type.

(3) *The Population of England and Scotland from late Bronze Age to Anglo-Saxon times.*

Very few skeletal remains of the population of England from the end of the Bronze Age to the Saxon invasion have been preserved and measured. That an alien people invaded the country at the beginning of that period, bringing iron implements and many other evidences of a new culture, is sufficiently well established. The practice of interring the dead in round barrows died out. Some Iron

* With the usual notation (see *Biometrika*, Vol. xvi. 1924, p. 12)

$$\alpha = \frac{(M_s - M_s')^2}{\sigma_s^2} \times \frac{n_s n_s'}{n_s + n_s'}.$$

Age barrows have been found in England, but we can get no determination of the physical type of their builders from the few skeletons for which measurements have been given. Cremation was common. In 1894 an ancient cemetery was discovered near Brandon in Suffolk and by the following year fragments of 121 skeletons had been disinterred. An account of the skulls with measurements of 57 of them has been given by Prof. C. S. Myers (26). No bones were found at a greater depth than 4 ft. and the absence of ornaments and pottery and the non-observance of any definite orientation of the bodies made any exact determination of the age of the burials impossible. Large pieces of iron were dug up but they had so far decayed that their former use could not be ascertained. The remains are almost certainly of pre-Saxon date. Myers proceeded to sub-divide the series into several groups which were supposed racially distinct; the Romano-British, the Long-Barrow and "the type of the slaves introduced into Britain at the time of or subsequent to the Roman invasion." No statistical justification whatever for such a procedure can be found. The standard deviation of the cephalic index of all the adult skulls—excluding the distorted specimens—is $2{\cdot}93 \pm {\cdot}20$, a value lower than that of the Whitechapel ♂ series; and the other indices show variabilities that are not at all greater than those of a homogeneous population. The standard deviations of all the direct measurements, too, are not significantly greater than those of the Whitechapel English ♂ skulls, although ♂ and ♀ skulls were said to be found in almost equal numbers at Brandon. By supposing that all the skulls are of the same race and accepting the sexing given we arrive at the following mean values:

	L	B	H'
Males	186·3 (28)	141·0 (28)	130·8 (24)
Females	182·5 (22)	136·0 (21)	127·7 (18)

The differences between these supposed ♂ and ♀ means are much smaller than the corresponding differences usually found for recent races of man and we are obliged to question the accuracy of the sexing. The sample being too small to be treated by the method of the nonic*, the following rough method of mathematical sexing was applied†. Taking three characters —L, B and H'—each distribution was divided as nearly as possible into five histograms having equal bases and covering the entire range. For each particular character a skull falling in the central histogram was assigned the mark 0; -1 and $+1$ for the histograms below and above the central one respectively and -2 for the extreme left and $+2$ for the extreme right histogram. Individuals with a negative total of marks for the three characters were supposed ♀ and others ♂. In this way 24 ♂'s and 26 ♀'s were distinguished. But the sexes determined by the above method were in many cases different from those given by Myers; 18 of his 28 ♂'s remaining ♂ and

* See Karl Pearson, Osteometric Sexing, *Biometrika*, Vol. x. p. 479.

† This method is similar to that used by Pearson and Bell, *A Study of the Long Bones of the English Skeleton*, Part I. The Femur, p. 46.

10 becoming ♀, while 16 of his 22 ♀'s remain ♀ and 6 become ♂*. The mean measurements become:

	F	*B*	*H'*
Males	188·4 (24)	143·1 (23)	133·7 (16)
Females	181·1 (26)	135·2 (26)	126·4 (24)

and the sexual differences are now almost of the same order as for the Whitechapel English and other long series of modern crania†. If Professor Myers divided the whole series into three supposed racially different groups before sexing then the numbers in each were so small that the difficulty of sexing must have been greatly enhanced. The mathematical method is admittedly a rough one which is not unlikely to give the wrong sex to particular skulls, but we may suppose that the mean measurements derived in that way are more nearly accurate than those originally given. Professor Myers, like the greater number of English craniometricians writing at the end of the 19th century, does not define the measurements he has taken or give a reference to any paper in which the definitions may be found. As in other cases we may assume that the methods of measurement adopted were those given by Flower in his *Osteological Catalogue* of 1879 and not modified in the 2nd edition of 1907. Then the skull length is our *F*, the nasal height *NH'*. The orbital width is less than Broca's taken from the dacryon (O_1') and cannot be compared with it. The palatal measurements (defined by Flower, *Journal of the Royal Anthropological Institute*, Vol. x. 1880, p. 161) are not comparable with the Frankfurt lengths as measured in the Biometric Laboratory.

Although several thousand skeletons of the inhabitants of Roman Britain must have been disinterred, the number for which measurements have been provided hardly exceeds 200. The majority of the skulls termed Romano-British were found in coffins or with artifacts thought to be of the date of the Roman occupation and bearing signs of Roman workmanship or design. Skeletons not found with some such objects cannot be assigned to the period with any certainty. It has generally been assumed that the physical type of the Romano-Britons was far from pure; heterogeneous elements having been introduced by the Romans themselves and the non-Roman soldiers and slaves. The pure foreign types are seldom found because of the almost invariable custom of cremation and no *à priori* evidence to support the theory that the admixture of foreign blood was large enough to modify the physical type of the conquered people has ever been adduced. Measurements of so-called Romano-British crania are found in the following sources. It is doubtful in some cases whether they were actually contemporaneous with the Roman occupation, but all are almost certainly representatives of the

* Numbers 678, 682, 688, 692, 714, 735, 737, 742, 756, 761 were changed from ♂ to ♀ and Numbers 676, 689, 696, 759, 760 and 685 from ♀ to ♂.

† The Whitechapel English sexual differences are 7·3 for *F*, 6·0 for *B* and 7·4 for *H'*.

Iron Age population of England if that period be supposed to extend down to the time of the Anglo-Saxon invasion. Barnard Davis and Davis and Thurnam 44 ♂ and 11 ♀ (4, pp. 248—251; 19, Nos. 58, 59, 1309, 216; 20, Nos. 1483 and 1542); Flower (27, pp. 64—68), 16 ♂ and 8 ♀; Pitt-Rivers and Garson (8, following p. 243; 9, following Plate 142; 10, p. xiii and pp. 286 and 288; 11, p. 65) 45 ♂ and 17 ♀ and Rolleston (18, Vol. II. p. 676) has given measurements of 1 ♀. The Romano-British skulls of which measurements have been given came principally from the southern counties, but some were found in Yorkshire. A comparison of the measurements suggested that all the skulls were not of the same racial type. The C.R.L.'s in Table II are found between five groups of the ♂ skulls. The clubbing together of the Yorkshire and Shropshire skulls with those from Gloucestershire and Bath is justified by the fact that the northern and southern series are statistically identical.

TABLE II.

Coefficients of Racial Likeness between Various Series of English Romano-British Male Skulls.*

	Wiltshire (Pitt-Rivers) (34·6)	London and Kent (9·5)	Dorset, Somerset and Wilts. (Flower and Davis) (5·8)	Yorkshire, Shropshire, Gloucestershire and Bath (17·5)	Berkshire (10·3)
Wiltshire (Pitt-Rivers) (34·6)	— —	0·50 ± ·25 {13}*	0·69 ± ·25 {13}	9·44 ± ·45 {4}	17·48 ± ·45 {4}
London and Kent (9·5)	0·50 ± ·25 {13}	— —	0·33 ± ·24 {14}	5·13 ± ·38 {5}	10·67 ± ·38 {5}
Dorsetshire, Somersetshire and Wiltshire (Flower and Davis) (5·8)	0·69 ± ·25 {13}	0·33 ± ·24 {14}	— —	0·39 ± ·36 {6}	2·69 ± ·38 {5}
Yorkshire, Shropshire, Gloucestershire and Bath (17·5)	9·44 ± ·45 {4}	5·13 ± ·38 {5}	0·39 ± ·36 {6}	— —	4·59 ± ·36 {6}
Berkshire (10·3)	17·48 ± ·45 {4}	10·67 ± ·38 {5}	2·69 ± ·38 {5}	4·59 ± ·36 {6}	— —

The available evidence, which is admittedly of the slenderest kind, suggests that round about the time of the Roman occupation the population of the south of England—as judged from the Wiltshire, Dorsetshire, Somersetshire, London and Kent skulls, but excluding the specimens from Gloucestershire and Bath—was racially homogeneous. Clubbing those groups together we find that that population (40·5) is identical in type with the supposed contemporaneous one from

* The numbers in curled brackets following the C.R.L.'s are the numbers of characters on which each was based.

Brandon in Suffolk (14·9)*. The C.R.L.'s between the ♂ means are 0·50 ± ·23 for 16 characters and 0·41 ± ·30 for the 6 available indices and angles. It is found that the combined Brandon and southern English Romano-British populations fulfil sufficiently well the other conditions of racial homogeneity. The *P*'s for goodness of fit of normal curves to three of the distributions are :

	F	*B*	100 *B*/*F*
Probability *P* ...	·488	·701	·420
Number of Groups	14	13	16
Number of Skulls	89	86	86

and the standard deviations of characters are all of the same order and actually all slightly smaller than the corresponding values for the Whitechapel English series. The one short series from Berkshire, and the series from Yorkshire, Shropshire, Gloucestershire and Bath, are distinctly different from the southern type and from one another.

Measurements of the Iron Age skulls of Scotland were collected together by Sir William Turner in his classical paper (12, Tables VI, VII and VIII). Some were possibly of Anglo-Saxon date, but the majority were undoubtedly earlier. There again the number of skulls is too small to give a reliable determination of type. The means are remarkably similar to those of the southern English Romano-British type and the C.R.L.'s show that there is full justification for considering the two populations to be identical. Between the Scottish (10·8) and English (52·7) ♂ series the C.R.L.'s are 0·25 ± ·21 for 19 characters and − 0·44 ± ·33 for the 7 indices and angles. The combined means are shown in Table XII, and they will be referred to as those of the British Iron Age type. As far as we are able to tell, the population of the two countries in that epoch was very nearly homogeneous. The aberrant types of the skulls from the Midland counties of England are not sufficiently well established to afford evidence of the existence of another racial type. The differences—which are nearly all ones of size—may be due to the selection of merely local variations or possibly to alien elements. A comparison of all the characters that show significant differences is made in Table III.

TABLE III.

Mean Male Measurements of Iron Age Series of Skulls.

	F	*L*	*B*	100 *B*/*F*	*U*	*S*	100 *B*/*L*
Southern English Counties	186·8 (65)	188·4 (43)	141·4 (63)	75·7 (63)	528·1 (62)	384·5 (8)	75·3 (43)
Brandon	188·4 (24)	—	143·1 (23)	76·1 (23)	—	—	—
Scotland	—	184·2 (18)	138·8 (16)	—	529·3 (11)	376·3 (12)	74·5 (17)
Berkshire ...	193·9 (11)	—	149·6 (11)	77·2 (11)	552·2 (11)	390·7 (9)	—
Yorkshire, Shropshire, Gloucestershire and Bath	186·3 (19)	—	146·5 (17)	78·6 (17)	538·8 (19)	376·5 (19)	—

* Using the re-sexed means.

The standard deviations of characters of the British Iron Age population are shown in Table XIV and for the goodness of fit of normal curves to the ♂ distributions the following probabilities are found:

	L	B	100 B/L
Probability P ...	·459	·994	·880
Number of Groups	13	14	14
Number of Skulls	61	102	57

These criteria bear out the assumption made that the population is racially homogeneous.

Having obtained the mean measurements of the type extant in England and Scotland in the Iron Age we may compare them with those of the two earlier prehistoric races. The C.R.L.'s between the three series are given in Table IV.

TABLE IV.

Coefficients of Racial Likeness between Early Series of British Crania.*
Male Means.

		British Neolithic (38·0)	English Bronze Age (32·6)	British Iron Age (53·4)
British Neolithic (38·0)	All Characters ...	—	56·55 ± ·18 {26}	10·94 ± ·20 {22}
	Indices and Angles	—	91·93 ± ·30 {9}	19·65 ± ·33 {7}
English Bronze Age (32·6)	All Characters ...	56·55 ± ·18 {26}	—	25·28 ± ·20 {22}
	Indices and Angles	91·93 ± ·30 {9}	—	38·95 ± ·33 {7}
British Iron Age (53·4)	All Characters ...	10·94 ± ·20 {22}	25·28 ± ·20 {22}	—
	Indices and Angles	19·65 ± ·33 {7}	38·95 ± ·33 {7}	—

The striking feature common to all the C.R.L.'s shown in Table IV is their high value. We are evidently dealing not with local and closely related types, but with distinct racial populations which are as markedly contrasted as almost any that are to be found in Europe to-day. The Iron Age series, containing more skulls than the other two, is likely to show larger coefficients with them than they would with one another if all three were equally related, and yet its coefficients are markedly smaller than those between the Bronze Age and Neolithic types. The Iron Age type thus takes up a position intermediate between the other two. In comparing individual characters it must be remembered that

* The numbers in round brackets, following the designations of the types, are the mean numbers of skulls available for each type for the characters used in computing the C.R.L.'s. The numbers in curled brackets following the coefficients are the numbers of characters on which each coefficient is based.

all the means of the facial measurements of the three types are based on small numbers of crania and they are, for that reason alone, less likely to show significant differences than the more adequately determined measurements of the brain-box. Between the Neolithic and English Bronze Age populations, 4 characters which are not available for the Iron Age series can be compared. They are 100 $G'H/GB$, 100 fmb/fml, G_2 and fmb, and they show no significant differences. Of the 22 characters available for all three series, 8—B', LB, $G'H$, NH', O_1', fml, $N\angle$ and $A\angle$—show no significant differences whatever. The constancy of the forehead breadth (B') and nasio-basion length (LB) is all the more remarkable because the greatest length and greatest breadth of the calvaria show more markedly significant differences than any other direct characters.

The values of α* greater than 5 shown for the 14 characters are given in Table V. A comparison of the values of α between the three series emphasises the extreme importance of the length and breadth of the calvaria and the resulting cephalic index as the characters which provide the clearest racial differentiation. In each case the combined values of α for those three characters are many times greater than the sum of the α's for all the other characters, and the α for 100 B/F is very significantly greater than the α for any other single character. This distinctive feature of the cephalic index is very frequently found in comparing members of the same family of allied races and the importance which Anders Retzius attached to the character is entirely justified by statistical comparison. Apart from the dimensions and shapes in *norma verticalis* of the brain-boxes—affecting the characters 100 B/F, B, F, S, 100 B/H' and 100 H'/F—and the zygomatic breadths, the three British types are not markedly dissimilar. The greater zygomatic and nasal breadths of the English Bronze Age type distinguish it clearly from the other two, but no other clear differences between the conformations of the facial regions of the Neolithic and Iron Age types can be detected. The material is not ample enough to provide justification for the statement that in reality there are no such differences. Considering the actual mean measurements (Table XII) it may be noted that for all the characters, except J, which show the greatest differences between the three prehistoric types—viz. 100 B/F, B, F, S, 100 B/H', 100 H'/F, NB and 100 NB/NH'—the Iron Age type has mean measurements intermediate between those of the Neolithic and Bronze Age populations.

The English Iron Age skulls that have as yet been considered were not found definitely associated with the peculiar artifacts to which the name "Late Celtic" is now usually applied. That new culture is supposed to have been introduced into England and Scotland by an immigrant race which came in large numbers, took up its settled habitation in the country and eventually formed an important element in the jumbling of races from which the population of mediaeval England is supposed to have been made up. It is very frequently stated that this Celtic people was brachycephalic and of a type differing from that of the earlier Bronze Age invaders, but it appears that the only evidence in support of that statement

* See footnote, p. 66.

is the fact that the carriers of the same culture in neighbouring countries—notably France—were of a distinct brachycephalic type. Very few remains of the people who introduced or adopted the new culture in England are extant as cremation was their almost invariable practice. Apart from isolated skulls, all the available skeletal material has been obtained from a single cemetery near Driffield in the East Riding of Yorkshire. Remains of chariots, weapons, personal ornaments and pottery were found in small mounds or barrows and all could be assigned to the late Celtic period, though known locally as the "Danes' Graves." Measurements of 22 of the skulls were published by William Wright in 1903 (24) and the length, breadth, cephalic index and, in some cases, the forehead breadth of 37 additional specimens were furnished by the same writer in an appendix to a paper by Canon Greenwell three years later (25). The mean measurements of that combined material are given in Table VI, with the combined English and Scottish Iron Age ♂ means. Wright distinguished 5 types, all of which were dolichocephalic, but since the means do not, as far as they go, indicate a heterogeneous population we need not suppose that the assembly was such a cosmopolitan one.

The "Danes' Graves" skulls have lower cephalic indices than the English and Scottish Iron Age type, so there is not the slightest suggestion of their bearing any close blood relationship to the brachycephalic peoples associated with the "Late Celtic" culture on the continent. The ♂ means of the direct measurements are nearly all smaller than those of the Iron Age population, and in many cases the differences would be quite significant. But we may suspect that the discordance there is not due to a real difference between the types. The differences between the ♂ and ♀ Danes' Graves means are decidedly smaller than those ordinarily found. The sexual differences compared with those for the Whitechapel English series are:

	Whitechapel English	"Danes' Graves"
L	8·6	6·8
B	6·0	0·9
B'	4·9	1·5

The numbers are far too small to warrant any dogmatic statement, but we may take it to be at least probable that the supposed "Danes' Graves" ♂ skulls included several ♀'s. If the difference in absolute size from the Iron Age population may be supposed due to that cause then the two would seem to be more or less alike. The only characters showing significant differences would be the basio-bregmatic height (H') and the indices dependent on it ($100\,H'/L$ and $100\,B/H'$). It may be that the differences there are indicative of a real racial distinction, but no proof of that can possibly be given which depends on a mean based on no more than six skulls. It cannot be dogmatically asserted that the Danes' Graves skulls belong to a population which is different from that which was widely spread over England and Scotland in the late Celtic and Romano-British periods. We have, however, thought it best not to include them in our Iron Age series.

TABLE V.

Values of α between Early Series of British Male Crania.

	100 B/F	B	F	J	S	100 B/H'	100 H'/F	NB	100 NB/NH'	Bregma Q	U	H'	100 O_2/O_1'	O_2
Neolithic and English Bronze Age	754·87	334·42	181·56	64·31	51·25	51·01	16·72	9·61	9·46	8·83	0·19	0·18	0·56	0·04
Neolithic and Iron Age	118·64	15·72	63·34	0·05	7·02	14·78	2·51	0·07	0·04	1·22	10·19	5·04	5·46	5·23
English Bronze Age and Iron Age	235·75	151·24	26·40	69·14	1·25	24·50	10·96	8·99	1·99	17·49	10·79	2·98	1·62	1·44

TABLE VI.

Comparison of "Danes' Graves" and other Iron Age Skulls.*

	L	F	B	H'	B'	S_1	S_2	S_3	S	U
"Danes' Graves" ♂	185·2 (45)	182·3 (15)	134·3 (43)	135·3 (6)	96·1 (23)	125·6 (15)	131·3 (15)	112·4 (14)	369·8 (14)	514·4 (11)
"Danes' Graves" ♀	178·4 (14)	175·8 (6)	133·4 (14)	125·0 (2)	94·6 (11)	122·2 (6)	118·7 (6)	124·0 (4)	366·3 (4)	502·0 (6)
English and Scottish Iron Age Type ♂	187·4 (61)	187·2 (89)	141·4 (102)	132·9 (77)	98·0 (45)	127·6 (20)	129·9 (20)	120·6 (20)	379·6 (20)	528·3 (73)
English and Scottish Iron Age Type ♀	179·7 (22)	180·8 (58)	136·2 (62)	126·5 (42)	97·1 (13)	123·7 (11)	123·0 (10)	115·7 (10)	362·0 (10)	510·7 (31)

	$G'H$	J	NH'	NB	O_2	100 B/L	100 H'/L	100 B/H'	100 NB/NH'	100 $G'H/GB$
"Danes' Graves" ♂	66·6 (10)	125·6 (5)	49·6 (11)	23·6 (8)	34·9 (7)	{72·5 (43)}	74·0 (6)	{99·3 (6)}	46·9 (8)	{74·0 (5)}
"Danes' Graves" ♀	64·8 (5)	117·7 (3)	48·7 (6)	23·0 (6)	33·8 (6)	{74·8 (14)}	70·5 (2)	—	47·2 (5)	{73·6 (4)}
English and Scottish Iron Age Type ♂	69·1 (30)	130·6 (55)	50·6 (99)	23·7 (67)	33·6 (65)	{75·4 (61)}	{70·9 (61)}	{106·3 (77)}	{46·8 (67)}	—
English and Scottish Iron Age Type ♀	63·6 (18)	123·8 (24)	47·9 (30)	23·5 (28)	33·1 (29)	{75·8 (22)}	{70·4 (22)}	{107·7 (42)}	{49·1 (28)}	—

* Some of the available "Danes' Graves" means which are based on five or fewer crania have been omitted from this table. The indices in curled brackets were calculated from the means of the component lengths.

(4) *English Anglo-Saxon Crania and their Relationships to Earlier British Types.*

It is customary to apply the term Anglo-Saxon to that period of English history which followed the departure of the Roman legions and preceded the Norman Conquest. But it is only for the first half of that epoch—roughly until the union of the several kingdoms under Alfred in 886—that we have any evidence relating to the physical type of the invaders. The characteristic Anglo-Saxon cemeteries in which weapons, ornaments and numerous other distinctive artifacts are found alongside the bodies, all belong to the earlier period and the majority are prior to the conversion of the inhabitants to Christianity at the beginning of the 7th century. Graveyards of the 10th and 11th centuries have frequently been found, but they were of little interest to archaeologists as the practice of interring artifacts with the body had died out by that time and no skulls of the period appear to have been preserved. Records of the excavations of a large number of cemeteries which can be assigned to the earlier centuries are to be found in *Archaeologia* and in the *Proceedings* of various county archaeological societies, but unfortunately few of the skeletons are at present available for study, the usual practice having been to re-inter them. All the material is in a fragile and incomplete condition, the shallow inhumations, usually in wooden coffins or without coffins at all, being ill-adapted to preserve the skeletons, and in that respect they are contrasted with the prehistoric remains which were protected by stone cists and tumuli.

The individual measurements of all the Anglo-Saxon crania in the Museum of the Royal College of Surgeons, the London Museum and the British Museum (Natural History) will be found in Appendix II, together with some particulars relating to the various graveyards. A qualitative comparison of all that material suggested that not more than one racial type was represented—a muscular dolichocephalic type which at first sight only appeared to differ from that of the 17th century English, as represented by the Whitechapel, Moorfields and Farringdon Street series preserved in the Biometric Laboratory, in having a greater calvarial height. No examples of the type of skull with a markedly retreating frontal bone, which is so peculiar to the modern English skulls, were found among the earlier populations.

To supplement the measurements of the crania in London museums, all previously published measurements of other Anglo-Saxon crania were collected together and pooled with them*. The whole material is still very meagre—particularly for facial measurements—and there is an urgent need for more Anglo-Saxon skeletal remains in our museums†. The only writers who have given measurements of Anglo-Saxon skulls other than those in London museums are

* Measurements of the majority of the skulls in the Royal College of Surgeons had previously been published, but they were always few in number (see Appendix II). The Mitcham skulls in the London Museum and the Sleaford in the British Museum (Natural History) had not previously been dealt with.

† The measurements of the long series discovered at Bideford-on-Avon in 1923 would be a welcome addition to our knowledge.

Horton-Smith (16), Duckworth (28), Pitt-Rivers (9), Schmidt (29) and Davis and Thurnam (4).

The division of the invaders into Angli, Saxons and Jutes which Bede made, though it was not observed by other early writers, is still occasionally cited as evidence of their racial heterogeneity. Archaeological research has shown that in customs and cultural practices the Jutes are distinguished from the Angles and Saxons, but no such differences are found between the two latter*. Until the present, no attempt to investigate the question of racial admixture which is of the slightest biometric value has been made. The whole available material is so meagre that it cannot be answered yet with any finality. Division was made into the following four groups:

(1) *West Saxons:* chiefly from Wiltshire and Berkshire, but some from Oxfordshire, Gloucestershire, Buckinghamshire, Dorsetshire and Somersetshire.

(2) *South Saxons:* chiefly from London district (Mitcham) but some from Sussex and Essex.

(3) *Angles:* chiefly from Lincolnshire and Cambridgeshire but some from Yorkshire, Norfolk, Nottinghamshire and Northamptonshire.

(4) *Jutes:* from Kent.

The most important mean measurements of the ♂ skulls in each group are given in Table VII and the C.R.L.'s between those means are in Table VIII.

TABLE VII.

Mean Measurements of Various Groups of Male Anglo-Saxon Crania.

Character	West Saxons	South Saxons	Jutes	Angles
F	188·4 (34)	188·3 (13)	188·0 (15)	189·9 (32)
B	141·0 (36)	143·0 (22)	142·6 (15)	140·9 (30)
B'	97·4 (15)	98·1 (12)	97·4 (14)	96·5 (18)
H'	135·5 (9)	137·8 (8)	135·8 (8)	135·1 (6)
LB	103·8 (7)	105·9 (8)	103·7 (9)	103·1 (7)
S	378·0 (25)	382·6 (8)	382·5 (12)	379·1 (19)
U	529·8 (32)	534·7 (13)	535·8 (11)	531·6 (17)
G'H	69·6 (4)	72·2 (7)	74·1 (4)	70·9 (7)
J	133·3 (17)	129·7 (4)	136·8 (8)	130·8 (5)
NH'	52·7 (7)	52·8 (9)	55·1 (5)	50·7 (7)
NB	24·7 (8)	24·3 (7)	24·5 (7)	24·6 (6)
O_2	32·8 (8)	34·4 (7)	33·0 (7)	34·7 (7)
100 *B/F*	75·8 (45)	74·0 (16)	76·1 (11)	74·0 (40)
100 *H'/F*	74·0 (20)	71·1 (13)	72·9 (7)	70·4 (20)
100 *B/H'*	104·3 (21)	105·0 (14)	105·2 (7)	105·5 (19)
100 *NB/NH'*	49·5 (17)	46·1 (14)	45·7 (5)	47·3 (22)
Oc. I.	58·7 (5)	58·7 (6)	57·7 (9)	58·0 (15)
100 *G'H/GB*	71·0 (11)	73·8 (10)	77·8 (3)	77·9 (18)

* Cf. Chadwick, *The Origin of the English Nation*, 1907, p. 81: "The evidence of the social systems confirms in a striking manner Bede's statement that the inhabitants of Kent were of a different nationality from those of the surrounding kingdoms. We have seen that the historical evidence gives no confirmation of this statement, while the linguistic evidence is worthless. In the light of the facts pointed out above, however, there can be no doubt as to its accuracy....On the other hand, the evidence of the social systems has totally failed to substantiate the distinction drawn by Bede between the Saxons and the Angles."

TABLE VIII.

Coefficients of Racial Likeness between Groups of Anglo-Saxon Male Crania.*

	West Saxons (17·7)	South Saxons (10·6)	Angles (13·9)	Jutes (8·4)
West Saxons (17·7)	—	0·71 ± ·22 {18}	1·87 ± ·21 {19}	−0·20 ± ·22 {17}
South Saxons (10·6)	0·71 ± ·22 {18}	—	−0·09 ± ·21 {20}	−0·28 ± ·22 {17}
Angles (13·9)	1·87 ± ·21 {19}	−0·09 ± ·21 {20}	—	0·53 ± ·20 {22}
Jutes (8·4)	−0·20 ± ·22 {17}	−0·28 ± ·22 {17}	0·53 ± ·20 {22}	—

If the reader will compare the actual mean measurements of tee four groups of Anglo-Saxon skulls he will be persuaded that they represent populations which are extremely similar if not absolutely identical. The C.R.L.'s confirm that conclusion. Only one—that between the Angles and West Saxons—suggests any real difference of type. There were 26 characters which could be used in computing the coefficients: 20 of them show no significant differences whatever. All the values of α greater than 5 are given below:

	100 *B/F*	100 *H'/F*	100 *G'H/GB*	100 *NB/NH'*	*J*	*NH'*
West Saxons and South Saxons	5·36	7·66	1·67	6·07	—	0·18
West Saxons and Angles ...	9·61	15·00	13·21	3·18	1·16	3·19
Angles and Jutes	5·33	3·75	—	0·71	5·30	6·61

Before deciding whether the observed differences must be considered to indicate different racial types or not, it will be well to compare the ♀ means. They are (excluding the Jutish means which are quite unreliable because only based on 5 skulls):

	100 *B/F*	100 *H'/F*	100 *G'H/GB*	100 *NB/NH'*	*J*	*NH'*
West Saxons	76·5 (33)	72·1 (17)	72·4 (17)	50·1 (17)	126·1 (9)	48·5 (12)
South Saxons	73·4 (11)	72·5 (6)	70·8 (4)	50·7 (6)	126·0 (3)	49·3 (7)
Angles ...	74·8 (27)	70·6 (13)	71·9 (17)	50·9 (13)	121·8 (5)	47·7 (9)

The ♀ means show fewer significant differences than the ♂. For the latter almost all the highest values of α were occasioned by the high West Saxon means

* The figures in round brackets give, as usual, the mean numbers of skulls available for the characters used in computing the C.R.L.'s. Means based on fewer than five crania were neglected. The numbers in curled brackets are the numbers of characters used in computing the C.R.L.'s.

for the indices $100\,B/F$, $100\,H'/F$ and $100\,NB/NH'$ and the zygomatic breadth (J). But the only ♀ mean of the West Saxons that is distinguished in the same way is that for $100\,B/F$. We may reasonably conclude that the differences in the case of the other characters were merely due to chance causes and no significance need be attached to them. The distinctiveness of the high facial index ($100\,G'H/GB$) of the ♂ Angles is not confirmed by a comparison of the ♀ means and it, too, may be considered of no importance. But the case of the higher cephalic indices of both ♂ and ♀ series of West Saxon skulls cannot be dismissed in the same way. It may be noted that that type does not differ from the others by having a smaller length and greater breadth, such as might have resulted from admixture with a brachycephalic type like that of the English Bronze Age population. The question whether it will be legitimate to consider the pooled measurements of all the Anglo-Saxon skulls to represent a single homogeneous type may be largely decided by combining the several groups and examining the statistical constants of that population. The ♂ and ♀ standard deviations are given in Table XIV and it will be seen that they are of the same order as the Whitechapel English values. The variability of the ♀ skull breadth (B) is the sole distinctively great one*. For goodness of fit of normal curves to the distributions of all the Anglo-Saxon skulls the following probabilities are found:

	B		F		$100\,B/F$	
	♂	♀	♂	♀	♂	♀
Probability P ...	·705	·759	·566	·988	·589	·831
Number of Groups	15	8	12	7	15	9
Number of Skulls	103	67	93	63	112	77

We may conclude then that, *from the evidence at present available*, there is sufficient statistical justification for considering that all skulls found in England associated with Anglo-Saxon artifacts belong to a single homogeneous racial type. Some of the invaders may have been modified by admixture with the indigenous population, but the modification of type effected in that way must in any case have been slight and the remains that have been preserved are insufficient in number to enable us to tell whether there was any such crossing or not. It should be remembered that hardly any of the Anglo-Saxons with which we are dealing were interred later than the 6th century. Provisionally then we may pool the West Saxons and the Jutes with the other groups to give the mean measurements of the accepted Anglo-Saxon type. The ♂ mean measurements are given in Table XII and the ♀ in Table XIII. The majority of the specimens were sexed by the present writer (see Appendix II) and a comparison of the sexual differences between the means with the differences for the sufficiently long Whitechapel

* A possible cause of large standard deviation of B, though one we should be loath to accept, is to be found in the fact that after restoration the breadths are more likely to be incorrect than other measurements.

series suggests that that was done adequately. For the characters below both ♂ and ♀ means were based on more than 50 skulls.

	Anglo-Saxon Sexual Difference	Whitechapel Sexual Difference
F ...	8·0	7·3
B ...	6·1	6·0
B′ ...	3·0	4·9
U ...	21·1	20·5

There is a satisfactory agreement between the ♂ and ♀ Anglo-Saxon mean indices. The Coefficients of Racial Likeness given in Table IX are found with the series of ♂ means.

TABLE IX.

Coefficients of Racial Likeness with Anglo-Saxon Male Means.*

		British Iron Age (53·4)	British Neolithic (38·0)	English Bronze Age (32·6)
Anglo-Saxons (41·2)	All Characters ...	3·67 ± ·20 {22}	6·82 ± ·18 {26}	24·19 ± ·18 {27}
	Indices and Angles	3·25 ± ·33 {7}	10·81 ± ·30 {9}	40·51 ± ·29 {10}

Of all the C.R.L.'s between the four racial types compared in Tables IV and IX that between the Anglo-Saxons and Iron Age British is the only one low enough to suggest a close relationship. These two later types take up positions which are intermediate between those of the extremely dissimilar Neolithic and English Bronze Age populations, being closer to the former than to the latter. It cannot be said that either the one or the other of the intermediate types, i.e. Anglo-Saxon and Iron Age, stands closer than its fellow to either of the extremes, namely Neolithic and Bronze Age. In comparing the Anglo-Saxons with each of the other three types it is found that the characters $100\,NB/NH'$, $100\,O_2/O_1'$, U, $G'H$, O_1', O_2, *fml*, $A\angle$, *fmb*, $100\,fmb/fml$ and G_2—the last three not being available for the Iron Age population—show no significant differences whatever. The values of α between the other measurements compared are shown in Table X.

With the Neolithic and English Bronze Age types the most marked differences are almost precisely the same as those between the Iron Age type and the same two populations (see Tables V and X); the cephalic indices differ most profoundly and then, in order, the characters B, F, $100\,B/H'$ and J. The basio-bregmatic heights, nasio-basion lengths (LB), frontal breadths (B') and facial characters other than the zygomatic breadth (J) are almost identical for the three types. For the characters showing greatest differences between the Neolithic and

* The numbers in curled brackets following the C.R.L.'s are the numbers of characters on which each is based.

TABLE X.

Values of α between the Anglo-Saxon and other British Male Series.

	100 *B*/*F*	*B*	*F*	*J*	100 *B*/*H′*	100 *H′*/*F*	Bregma *Q*	*S*	*H′*	*LB*	*B′*	*NH′*	*NB*	*N*∠	*P*∠
Anglo-Saxon and British Iron Age	5·50	0·20	4·02	7·12	3·57	2·89	11·13	0·00	8·40	8·41	0·76	12·72	12·72	11·68	—
Anglo-Saxon and British Neolithic	82·51	19·83	36·26	7·55	5·50	8·17	0·53	9·81	0·14	0·51	2·90	0·91	0·91	3·21	—
Anglo-Saxon and English Bronze Age	350·63	141·32	52·14	23·78	37·91	4·01	17·39	2·08	0·50	1·31	8·73	1·21	1·21	4·30	6·19

TABLE XI.

Mean Male Measurements distinguishing the Neolithic and Bronze Age Populations.

	100 *B*/*F*	*B*	*F*	*J*	*S*	100 *B*/*H′*	100 *H′*/*F*	*NB*	100 *NB*/*NH′*	Bregma *Q*
British Neolithic ...	71·7	138·9	193·6	130·4	389·0	102·5	70·0	23·6	45·4	308·5
Anglo-Saxon ...	74·9	141·7	188·9	133·3	379·8	104·9	72·0	24·5	47·5	316·1
British Iron Age ...	75·8	141·4	187·2	130·6	379·6	106·3	71·1	23·7	46·8	303·6
English Bronze Age	82·0	149·9	182·8	138·5	376·6	111·2	73·4	25·0	48·3	320·5

Bronze Age populations the differences between the Anglo-Saxon and British Iron Age skulls are small, if significant at all, while the two later types show significant differences for several characters which do not at all differentiate the Anglo-Saxon, Neolithic and English Bronze Age types. The position will be made more clear if we consider only the characters which show significant differences between the Neolithic and English Bronze Age types (see Table V). The means for all such characters are given in Table XI.

A striking fact is brought out by a comparison of the mean measurements given in Table XI. For every single character showing a significant difference between the Neolithic and English Bronze Age populations, the Anglo-Saxon means are intermediate in value between the contrasted values for the two earlier populations. The suggestiveness of that relationship is greatly enhanced when we observe that, with one exception, all the other measurements that may be compared are statistically identical for the three types. The exception is for the frontal breadth (B'), the Anglo-Saxon mean of 97·3 being smaller than the Neolithic (98·7) and significantly less than the English Bronze Age value (99·7). That discordance, however, may not be of importance*. There may be something to be said for the hypothesis that the Anglo-Saxon invaders of our shores were originally related to two contrasted racial types which were akin to the ones found in England in the late Neolithic and Bronze Age respectively, the Neolithic element predominating. A comprehensive study of the craniology of Europe in late prehistoric times could alone prove or disprove that theory with any definiteness. What now of the British Iron Age type? Being very similar to the Anglo-Saxon, it has many important characters intermediate between the English Bronze Age and Neolithic values (see Table XI), but three shown in the table—viz. J, NB, and $100\,NB/NH'$—are not differentiated from the Neolithic values, and the small basio-bregmatic height and transverse arc of the Iron Age skulls differentiate them, though not very markedly, from the other three types and give a close bond with the 17th century London skull which the others lack. It is extremely unlikely that such a type was compounded from the earlier populations of Britain which are known to us.

(5) *Mean Female Measurements of Early British Series of Crania.*

For all the series of which the ♂ mean measurements have been dealt with in earlier sections of this paper, the ♀ data are less plentiful than the ♂. The Neolithic means given in the second column of Table XIII are those of English and Scottish skulls of Neolithic date. The ♀ Bronze Age population is too small to make any approximate disintegration by mathematical methods, similar to that used in the case of the ♂ skulls, at all worth while. The only ♀ Neolithic means based on numbers that are at all adequate indicate a type that is distinguished from all later ones by its great length and low cephalic index, and the agreement between the ♂ and ♀ indices is quite satisfactory. For the Iron Age

* It may be noticed that the Anglo-Saxon sexual differences (p. 79) are almost precisely the same as for the Whitechapel English except for B'. The Anglo-Saxon ♀ B' does not differ at all from the Neolithic and Bronze Age values.

TABLE XII.

Comparative Table of English and Scottish Mean Skull Measurements for Various Periods. Male Skulls.

Character	English and Scottish Neolithic	English Bronze Age	Scottish Bronze Age	English and Scottish Iron Age	Anglo-Saxon	Whitechapel English‡ (17th Century)
Capacity*	[1533·2 (25)]	[1564·4 (25)]	[1560·9 (30)]	[1487·8 (61)]	[1543·3 (31)]	1476·9 (72)
L†	193·7 (53)	184·5 (48)	180·7 (34)	187·4 (61)	190·6 (58)	189·1 (137)
F	193·6 (116)	182·8 (90)	181·6 (5)	187·2 (89)	188·9 (94)	187·4 (138)
L′	191·9 (7)	185·3 (7)	—	—	190·0 (16)	187·8 (72)
B	138·9 (128)	149·9 (89)	150·1 (33)	141·4 (102)	141·7 (103)	140·7 (135)
B′	98·7 (41)	99·7 (43)	—	98·0 (45)	97·3 (59)	98·0 (132)
H	136·3 (7)	141·3 (3)	—	—	137·7 (16)	—
H′	135·5 (25)	134·9 (25)	137·2 (30)	132·9 (77)	136·0 (31)	132·0 (122)
OH	117·6 (8)?	121·1 (7)?	—	—	114·9 (17)	112·1 (135)
LB	103·3 (21)	102·9 (27)	99·4 (21)	101·6 (67)	104·1 (31)	101·6 (119)
Q′	313·7 (15)	333·9 (7)	—	—	316·1 (23)	—
Bregmatic *Q*	308·5 (10)	320·5 (15)	318·5 (17)	303·6 (10)	—	307·9 (115)
S	389·0 (31)	376·6 (62)	375·4 (24)	379·6 (20)	379·8 (64)	377·1 (131)
S_1	132·5 (27)	131·1 (61)	128·4 (30)	127·6 (20)	129·3 (83)	—
S_2	133·9 (26)	128·1 (57)	129·6 (31)	129·9 (20)	129·0 (87)	—
S_3	123·3 (20)	117·9 (42)	116·7 (25)	120·6 (20)	121·7 (71)	—
U	536·6 (106)	535·6 (81)	525·0 (26)	528·3 (73)	532·0 (73)	524·3 (131)
G′H	70·8 (32)	69·1 (30)	68·5 (15)	69·1 (30)	71·7 (22)	70·2 (75)
GB	95·3 (11)	98·0 (11)	—	—	95·0 (19)	90·9 (55)
J	130·4 (41)	138·5 (40)	135·1 (14)	130·6 (55)	133·3 (34)	130·1 (43)
NH, *R*	50·6 (15)	49·1 (13)	—	—	52·2 (22)	51·2 (79)
NH, *L*			—	—	52·3 (22)	
NB	23·6 (34)	25·0 (28)	24·5 (17)	23·7 (67)	24·5 (28)	24·3 (70)
NH′	52·0 (21)	51·8 (16)	50·2 (19)	50·6 (99)	52·7 (28)	50·3 (76)‡
O_1R	42·3 (3)	44·0 (14)	—	—	42·9 (19)	43·0 (68)
O_1L			—	—	42·2 (16)	43·1 (61)
O_2R	32·6 (27)	33·0 (30)	32·2 (16)	33·6 (65)	33·6 (29)	33·4 (69)
O_2L					33·5 (27)	33·5 (67)
O_1' §	39·8 (22)	39·7 (17)	40·6 (16)	39·3 (21)	40·3 (16)	40·5 (67)‡
G_1	—	—	—	—	50·1 (20)	48·3 (69)
G_2	40·2 (7)	42·4 (10)	—	—	41·3 (27)	39·6 (32)‡
GL	96·8 (16)	96·4 (20)	93·6 (16)	96·3 (63)	96·0 (22)	95·9 (73)
fml	36·3 (17)	36·1 (20)	35·9 (20)	35·8 (11)	37·5 (20)	35·9 (117)‡
fmb	30·4 (7)	31·1 (14)	—	—	31·1 (18)	30·3 (112)‡
100 *B*/*F*	{71·7 (116)}	{82·0 (89)}	{82·7 (5)}	{75·8 (86)}	74·9 (112)	{75·1 (135)}
100 *B*/*L*	{71·7 (53)}	{81·3 (48)}	{83·1 (33)}	{75·4 (61)}	74·7 (52)	74·3 (131)
100 *H′*/*F*	{70·0 (25)}	{73·4 (25)}	{75·6 (5)}	{71·1 (63)}	72·0 (60)	{70·4 (122)}
100 *H′*/*L*	{70·0 (25)}	{72·8 (25)}	{75·9 (30)}	{70·9 (61)}	71·2 (25)	70·0 (120)
100 *B*/*H′*	{102·5 (25)}	{111·2 (25)}	{109·4 (35)}	{106·3 (77)}	104·9 (61)	106·6 (122)
100 (*B* − *H′*)/*L*	{+1·8 (25)}	{+8·1 (25)}	{+7·1 (30)}	{+4·5 (61)}	+3·8 (24)	{+4·6 (122)}
100 *G′H*/*GB*	{74·3 (11)}	70·4 (13)	—	—	75·3 (43)	76·5 (53)
100 *NB*/*NH*, *R*	46·6 (15)	{50·9 (13)}	—	—	48·1 (19)	47·6 (70)
100 *NB*/*NH*, *L*			—	—	47·9 (19)	
100 *NB*/*NH′*	{45·4 (21)}	{48·3 (16)}	{48·8 (17)}	{46·8 (67)}	47·5 (58)	{48·3 (70)}‡
100 O_2/O_1, *R*	{76·8 (3)}	{75·2 (14)}	—	—	77·9 (19)	77·7 (68)
100 O_2/O_1, *L*			—	—	79·4 (16)	77·9 (63)
100 O_2/O_1'	{81·9 (22)}	{83·4 (17)}	{79·3 (16)}	{85·5 (21)}	83·3 (46)	{82·5 (67)}‡
100 *fmb*/*fml*	{83·7 (7)}	{86·1 (14)}	80·6 (1)	—	82·3 (18)	84·5 (112)‡
100 G_2/G_1	—	—	—	—	81·5 (18)	{82·0 (32)}‡
P∠	83°·3 (4)	84°·2 (5)	—	—	88°·1 (16)	86°·1 (63)
N∠	{64°·2 (16)}	{64°·4 (20)}	{64°·3 (15)}	{65°·6 (30)}	62°·1 (16)	65°·2 (69)
A∠	{74°·7 (16)}	{75°·3 (20)}	{74°·2 (15)}	{73°·5 (30)}	75°·5 (16)	73°·4 (69)
B∠	{41°·1 (16)}	{40°·3 (20)}	{41°·5 (15)}	{40°·9 (30)}	42°·4 (16)	41°·4 (69)
θ_1∠	—	—	—	—	30°·6 (13)	28°·7 (59)
θ_2∠	—	—	—	—	11°·9 (13)	12°·9 (59)

the numbers are large enough to give a good first approximation to the ♀ type and in shape there is a close resemblance to that of the contemporary ♂ skulls. Both show characteristically low calvarial heights and small $100\,H'/L$ indices. The nasio-basion lengths are also small and for both sexes the means are hardly distinguishable from those of the 17th century Whitechapel skulls. The distinctiveness of the Anglo-Saxon type is confirmed by the ♀ measurements. Some writers have suggested that the invading Anglo-Saxons came without their women

Notes to Table XII.

* The capacities in square brackets were reconstructed from the mean measurements by Hooke's formula for ♂ English skulls $C = \cdot 000366 \times L \times B \times H' + 198 \cdot 9$, using mean measurements. See the present issue of *Biometrika*, p. 33.

† It is usual to find for European races that the ♂ mean glabellar-occipital length (L) exceeds the mean ophryo-occipital length (F) by about 2 mm. when both are based on the same skulls. Some of the types for which measurements are given in the table do not show differences of that order because the means are not based on the same numbers of skulls. The divergences are not greater than those which may be expected to arise as the result of random sampling.

‡ The measurements O_1', NH', *fml* and *fmb* of the Whitechapel English were taken by the present writer with the kind permission of Professor Karl Pearson. Macdonell had not provided them in his paper (30). They give the additional indices $100\,O_2/O_1'$, $100\,NB/NH'$ and $100\,fmb/fml$. Macdonell had given the palatal width (G_2) of 66 of the ♂ skulls as 36·8, which is a peculiarly small value. I examined the whole series and only found 32 specimens with alveolar borders sufficiently well preserved to give unquestionably correct measurements. Their mean G_2 is 39·6 and I have ventured to use that value in place of Macdonell's for the direct measurement and for the palatal indices.

§ Almost all the individual dacryal widths on which these means are based are of the right orbit only, but some may have been of the left orbit in place of the right.

‖ The indices and angles in curled brackets were calculated from the means of the component lengths.

The following additional male mean measurements of the Anglo-Saxons and Whitechapel English are available.

	G_1'	$100\,G_2/G_1'$	DS	DC	DA	SS
Anglo-Saxons ...	46·1 (21)	88·2 (19)	12·6 (14)	22·2 (17)	31·7 (14)	4·4 (19)
Whitechapel English	44·7 (69)	*88·6 (32)	12·1 (50)	21·4 (50)	34·6 (50)	4·72 (50)

	SC	$100\,DS/DC$	$100\,SS/SC$	PH	S_3'	*Oc. I.*
Anglo-Saxons ...	9·2 (21)	58·0 (14)	47·3 (19)	19·8 (27)	98·5 (37)	58·2 (35)
Whitechapel English	9·43 (50)	57·4 (50)	51·2 (50)	—	—	—

	Q	G_1''	$EB = G_2$	EH	$100\,EH/EB$	$100\,H/L$
Anglo-Saxons ...	314·4 (15)	53·9 (17)	41·3 (27)	12·4 (16)	30·4 (16)	72·6 (15)
Whitechapel English	—	—	*39·6 (32)	—	—	—

The dacryal and simotic measurements of 50 ♂ Whitechapel skulls were first provided by Ryley and Bell (31, p. 397).

* See note ‡ above.

TABLE XIII. *Comparative Table of British Mean Female Skull Measurements for Various Periods.*

Character	British Neolithic	British Iron Age	Anglo-Saxon	Whitechapel English (17th Century)
Capacity	{1452·5 (61)}*	{1332·6 (22)}*	{1370·0 (28)}*	1299·9 (80)
F	186·5 (41)	180·8 (58)	180·9 (62)	180·1 (143)
L'	185·3 (3)	—	180·0 (23)	180·1 (57)
L	183·5 (13)	179·7 (22)	182·0 (55)	180·4 (140)
B	135·7 (42)	136·2 (62)	135·6 (67)	134·7 (140)
B'	94·2 (11)	97·1 (13)	94·3 (58)	93·1 (147)
H	138·8 (3)	—	130·3 (12)	—
H'	137·5 (6)	126·5 (42)	129·6 (28)	124·6 (124)
OH	115·5 (3)	—	110·5 (19)	109·2 (143)
LB	98·2 (6)	95·7 (34)	97·4 (26)	95·3 (122)
Q	309·0 (4)	—	301·7 (18)	—
Bregmatic *Q*	—	—	—	294·0 (122)
S	374·0 (18)	362·0 (10)	366·5 (38)	362·8 (130)
S_1	125·4 (14)	123·7 (11)	124·4 (63)	—
S_2	128·4 (14)	123·0 (10)	123·2 (57)	—
S_3	117·3 (13)	115·7 (10)	115·2 (46)	—
U	520·4 (30)	510·7 (31)	510·9 (54)	503·8 (136)
G'H	63·0 (4)	63·6 (18)	65·9 (30)	65·9 (62)
GB	94·2 (3)	—	90·2 (26)	84·9 (58)
J	125·0 (11)	123·8 (24)	125·6 (26)	120·3 (33)
NH, R	46·9 (5)	—	48·4 (29)	48·7 (67)
NH, L		—	48·0 (27)	
NH'	49·0 (1)	47·9 (30)	47·1 (32)	—
NB	23·0 (6)	23·5 (28)	24·2 (24)	23·2 (64)
O_2R	30·8 (4)	33·1 (29)	32·8 (27)	33·7 (64)
O_2L			32·9 (26)	33·6 (64)
O_1R	—	—	41·6 (23)	41·0 (62)
O_1'	38·8 (4)	37·0 (2)	38·9 (20)	—
G_1	—	—	51·2 (13)	45·1 (57)
G_2	36·0 (1)	—	39·9 (23)	35·2 (58)
GL	90·8 (3)	91·8 (28)	94·0 (19)	90·4 (58)
fml	34·5 (4)	—	35·5 (19)	—
fmb	30·1 (4)	—	28·9 (19)	—
100 *B/F*	{72·8 (41)}†	{75·3 (58)}	75·2 (77)	{74·8 (140)}
100 *B/L*	{74·0 (13)}	{75·8 (22)}	74·4 (51)	74·7 (130)
100 *H'/F*	{73·7 (6)}	{69·9 (42)}	71·6 (37)	{69·2 (124)}
100 *H'/L*	74·4 (5)	{70·4 (22)}	71·5 (27)	69·1 (117)
100 *B/H'*	{98·7 (6)}	{107·7 (42)}	105·7 (42)	108·5 (115)
100 *(B−H')/L*	{−1·0 (6)}	{+5·4 (22)}	+2·6 (21)	{+5·6 (124)}
100 *G'H/GB*	{66·9 (3)}	—	72·1 (41)	77·9 (54)
100 *NB/NH, R*	49·3 (4)	—	51·0 (20)	47·8 (64)
100 *NB/NH, L*		—	51·1 (20)	
100 *NB/NH'*	51·0 (1)	{49·1 (28)}	50·2 (38)	—
100 O_2/O_1, *R*	—	—	79·6 (23)	82·5 (62)
100 O_2/O_1, *L*	—	—	79·4 (24)	81·7 (57)
100 O_2/O_1'	78·0 (3)	96·0 (2)	84·5 (37)	—
100 G_2/G_1	—	—	76·1 (12)	77·7 (51)
100 *fmb/fml*	{87·2 (4)}	—	81·7 (18)	—
P ∠	—	—	83°·9 (20)	87°·1 (52)
N ∠	{64°·0 (3)}	{67°·0 (18)}	67°·2 (15)	64°·7 (57)
A ∠	{77°·3 (3)}	{73°·4 (18)}	72°·6 (15)	73°·9 (57)
B ∠	{38°·7 (3)}	{39°·6 (18)}	40°·1 (15)	41°·4 (57)
θ_1 ∠	—	—	29°·0 (11)	28°·1 (50)
θ_2 ∠	—	—	10°·2 (11)	13°·1 (50)

* These capacities are those given by Hooke's reconstruction formula $C = \cdot 000366 \times L \times B \times H' + 199 \cdot 4$ for English ♀ skulls, using mean measurements. See the present issue of *Biometrika*, p. 33.

† The indices and angles in curled brackets { } were calculated from the means of the component lengths.

folk and took wives from the natives they had conquered, but the direct evidence does not support that contention*. The ♂ and ♀ Anglo-Saxon skulls are clearly of the same racial type, which is chiefly distinguished from that of the British Iron Age people by its greater basio-bregmatic height and nasio-basion length. The agreement between the two sexes is less satisfactory for the mean facial measurements, all of which are based on smaller numbers than the calvarial, and the profile angles and angles of the fundamental triangle are particularly discordant. We may reasonably expect that lack of accordance to disappear when the means represent larger numbers of skulls.

The following additional mean measurements are available for the female Anglo-Saxons: $S_3' = 97{\cdot}1\,(33)$, *Oc. I.* $= 59{\cdot}7\,(32)$, $PH = 17{\cdot}2\,(32)$, $DS = 12{\cdot}1\,(16)$, $DC = 22{\cdot}0\,(21)$, $DA = 32{\cdot}6\,(16)$, $100\,DS/DC = 57{\cdot}3\,(16)$, $SS = 3{\cdot}8\,(19)$, $SC = 8{\cdot}7\,(23)$, $100\,SS/SC = 45{\cdot}4\,(19)$, $EB = G_2 = 39{\cdot}9\,(23)$, $EH = 10{\cdot}4\,(16)$, $100\,EH/EB = 26{\cdot}6\,(16)$, $G_1'' = 53{\cdot}6\,(12)$, $G_1' = 47{\cdot}0\,(13)$, (Whitechapel $G_1' = 41{\cdot}5\,(58)$), $100\,G_2/G_1' = 82{\cdot}9\,(12)$, (Whitechapel $100\,G_2/G_1' = \{84{\cdot}9\,(58)\}$)†, $Q = 299{\cdot}2\,(16)$, $O_1L = 41{\cdot}2\,(25)$, (Whitechapel $O_1L = 41{\cdot}2\,(57)$), $100\,H/L = 72{\cdot}5\,(12)$, $100\,B/H = 104{\cdot}2\,(12)$.

(6) *The Standard Deviations of Early British Series of Crania.*

In Table XIV are given the standard deviations of 6 characters, and the numbers of skulls on which each is based, for the series of which the mean measure-

TABLE XIV. *The Standard Deviations of Characters for Various British Series of Crania.*

Character	Males					Females	
	Whitechapel English (17th Century)	British Neolithic	English Bronze Age	British Iron Age	Anglo-Saxon	Whitechapel English	Anglo-Saxon
$100\,B/L$ or $100\,B/F$‡	3·26 ± ·14 131	3·02 ± ·13 116	3·14 ± ·16 89	3·17 ± ·16 86	3·12 ± ·14 112	2·98 ± ·12 130	3·23 ± ·18 77
L or F‡	6·27 ± ·25 137	6·36 ± ·28 116	5·88 ± ·30 90	5·71 ± ·29 89	5·49 ± ·27 94	6·22 ± ·25 140	5·93 ± ·36 63
B	5·28 ± ·22 135	4·65 ± ·16 128	6·67 ± ·34 89	5·08 ± ·24 102	5·79 ± ·27 103	4·77 ± ·19 190	6·11 ± ·35 67
H'	5·56 ± ·24 122	— —	— —	5·55 ± ·30 77	5·81 ± ·39 31	4·93 ± ·21 124	4·97 ± ·48 24
U	15·02 ± ·63 131	14·46 ± ·67 106	17·72 ± ·93 82	13·80 ± ·76 73	11·79 ± ·66 73	14·70 ± ·60 136	13·62 ± ·88 54
$100\,NB/NH, R$ or $100\,NB/NH'$	4·58 ± ·26 70	— —	— —	4·82 ± ·29 62	3·95 ± ·27 58	3·90 ± ·23 64	5·01 ± ·39 38

* Some standard deviations of the Anglo-Saxon ♀ measurements are given in Table XIV, and it will be seen that they indicate a population which is not more variable than that of the Whitechapel English from a single pit.

† The indices and angles in curled brackets { } were calculated from the means of the component lengths.

‡ The Whitechapel English standard deviations are for $100\,B/L$ and L while for all the other series in the table they are for $100\,B/F$ and F.

ments are in Tables XII and XIII. Where fewer than 30 crania were available the standard deviations were not calculated except in the case of the H' of the ♀ Anglo-Saxons, which is of special interest. The Whitechapel skulls came from a single pit and may be supposed contemporaneous. Each of the other series was made up by clubbing together the skulls of the same epoch from different, and often widely scattered, localities, and a period of several hundred years must be allowed between the dates of death of the earliest and latest individuals representing the same type. In spite of those differences there is on the whole a surprising parity between the variabilities of the modern series and the others. For the ♂ skulls there are only two standard deviations which differ significantly—by more than 2·5 times the probable error of the difference say—from the Whitechapel values. The standard deviation of the skull breadths of the Bronze Age skulls is significantly greater and the Anglo-Saxon variability of the horizontal circumference (U) is significantly less. In computing C.R.L.'s the assumption is made that all the series compared have the same variabilities for all characters as the standard Egyptian series—the E series of 26th to 30th Dynasty skulls from Gizeh. It is necessary to make that assumption in the present state of our knowledge, but it is probably only an approximation to the truth. It is more probable that the variabilities of a homogeneous series of the same race are peculiar to that race. It is at least suggestive that the Bronze Age skulls, which are the broadest and most brachycephalic, should have the greatest standard deviation of skull breadth while the most dolichocephalic and narrowest skulls—the Neolithic—have the least. The inter-racial coefficients of variation are probably more constant than the standard deviations. The numbers of skulls on which the constants in Table XIV are based are obviously too small to furnish really distinctive racial values, but we may rest assured that the Anglo-Saxon and prehistoric series compiled from various sources are as homogeneous as the series usually accepted by the craniometrician as racially unique.

(7) *Anglo-Saxon Type Contours.*

Male and female type contours (Figs. I—VI) of the Anglo-Saxon skulls in London museums were constructed from the measurements of contours of individual skulls by the methods first used by Benington and described in detail in *Biometrika*, Vol. XIV. 1923, pp. 227—240. In dealing with a cranial series in that way it has been customary to exclude all specimens with defective facial bones for which the Frankfurt horizontal plane cannot be determined, but, as a large proportion of the small total population of Anglo-Saxon skulls would have been excluded by following that practice, it was thought better to use the contours of the imperfect skulls. That was done by supposing that the vertex of such a one was 10·5 mm. behind the bregma in the case of a ♂ skull and 12·9 mm. behind in the case of a ♀, while the gamma was taken 30·8 mm. below the lambda for a ♂ skull and 29·0 mm. below for a ♀, all the points being located, of course, in the median sagittal plane. Those distances are the means given by the complete skulls. The mean contour measurements of the complete and incomplete

series were then calculated separately and found to agree closely. The following, given by the ♂ horizontal contours, are typical.

		Complete Skulls	Incomplete Skulls (Gamma taken 30·8 from lambda)
Ordinates	*FO*	191·7 (19)	190·4 (21)
	3*R*	51·2 (19)	49·7 (19)
	5*R*	65·6 (19)	63·6 (14)
	7*R*	70·9 (18)	70·2 (19)
	9*R*	60·1 (17)	59·4 (23)

The pooled mean measurements from which the types were constructed are given in Tables XV, XVI and XVII, and they show a satisfactory agreement with the means of the direct measurements with which comparison can be made. The numbers of skulls are large enough to give good first approximations to the type outlines except in the case of the facial section of the sagittal contours. The most significant differences between the Anglo-Saxon skull and that of the 17th century Londoners can be clearly appreciated by superposing the profile views—whether ♂ on ♂ or ♀ on ♀—with the aid of the tracings provided for both in this number of *Biometrika*. In place of the low calvaria and markedly retreating forehead of the more modern type, the Anglo-Saxons had a reasonably high brain-box and quite a prominent frontal bone.

(8) *Measurements of Anglo-Saxon Mandibles.*

Measurements of all the Anglo-Saxon mandibles in the Museum of the Royal College of Surgeons, the British Museum (Natural History) and the London Museum were taken by the methods described in detail in *Biometrika*, Vol. XIV. 1923, pp. 253—260. All old, senile and immature bones were excluded, as were those of which the form might possibly have been modified by the loss of a considerable number of teeth. Of the remaining 132 specimens, the sex of 98 (49 ♂ and 49 ♀) could be judged from the skull and the isolated mandibles were supposed ♂? or ♀? after a careful comparison with the ones for which the complete skulls were available. Without some such control the sex determined from the lower jaw alone is certainly more uncertain than that determined from the skull without the mandible. The series is longer than any previous one measured by the same methods, but, owing to the defective state of many of the specimens, the means (Table XVIII) are not based on sufficiently large numbers to make it worth while to calculate the constants of variation and correlation. The proportional sexual difference in size appears to be of the same order as that found for calvarial and facial measurements and the ♂ and ♀ indices and angles are so similar that, for the small numbers dealt with, the differences would almost certainly not be significant.

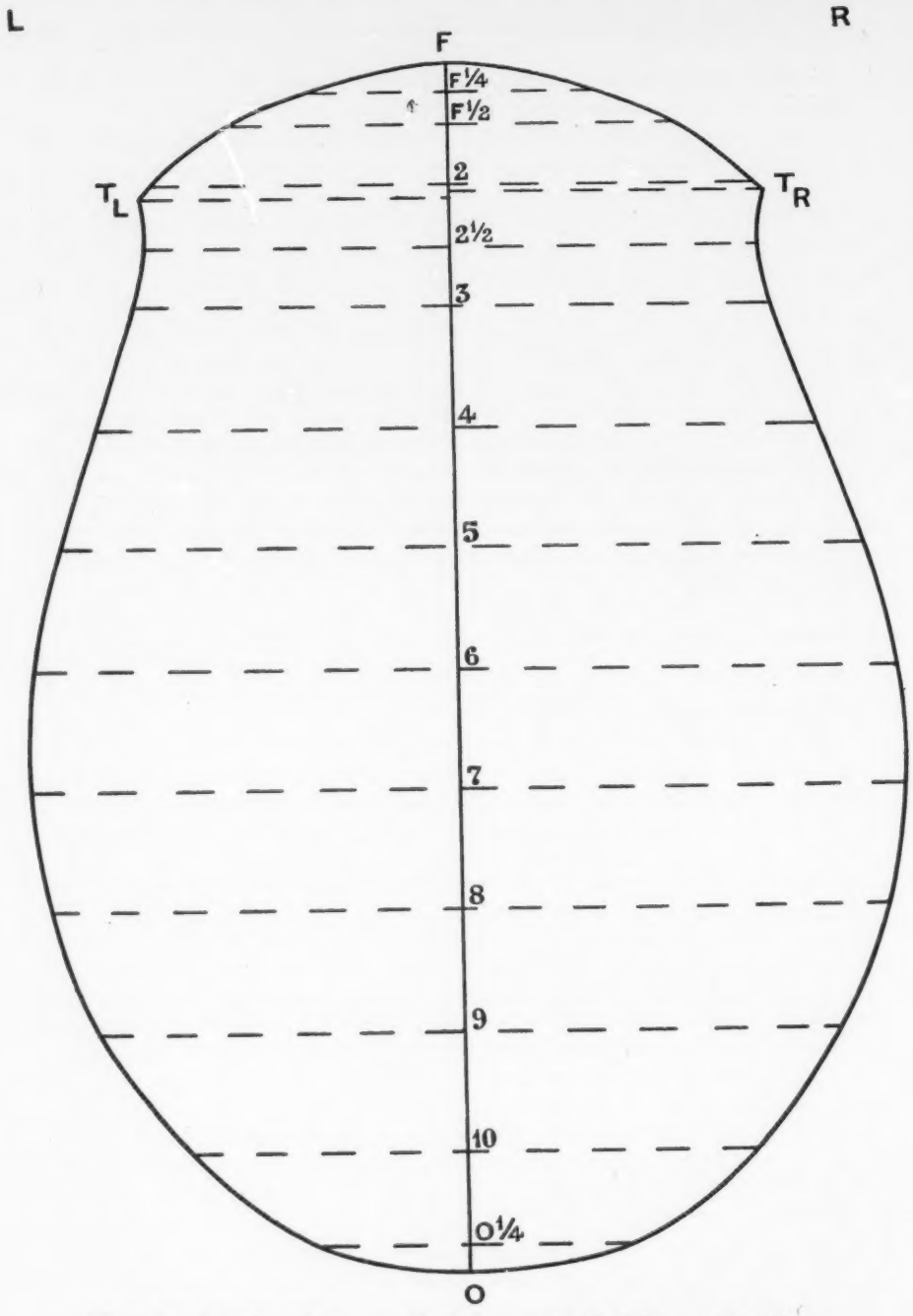


FIG. I Anglo-Saxon ♂ Horizontal Type Contour.

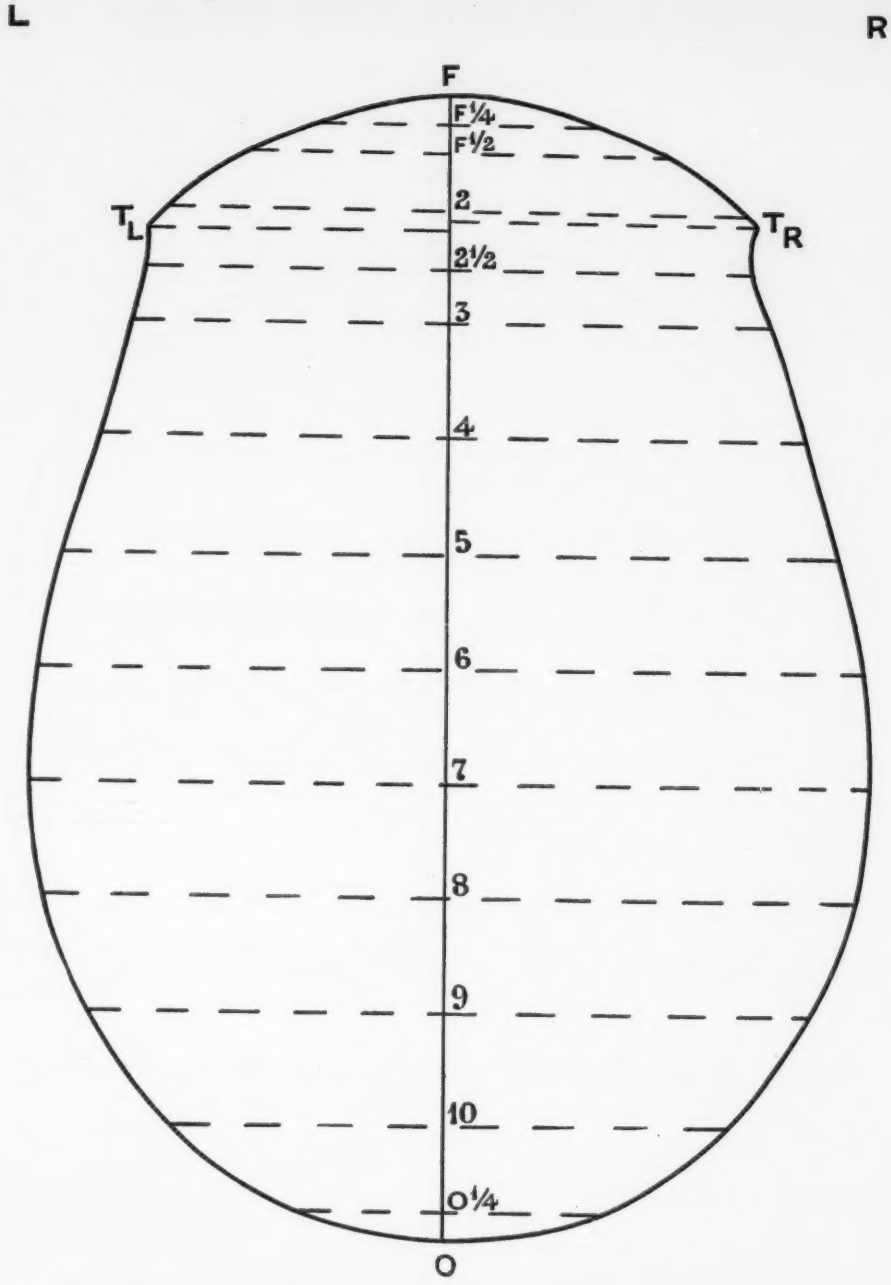


FIG. II Anglo-Saxon ♀ Horizontal Type Contour.

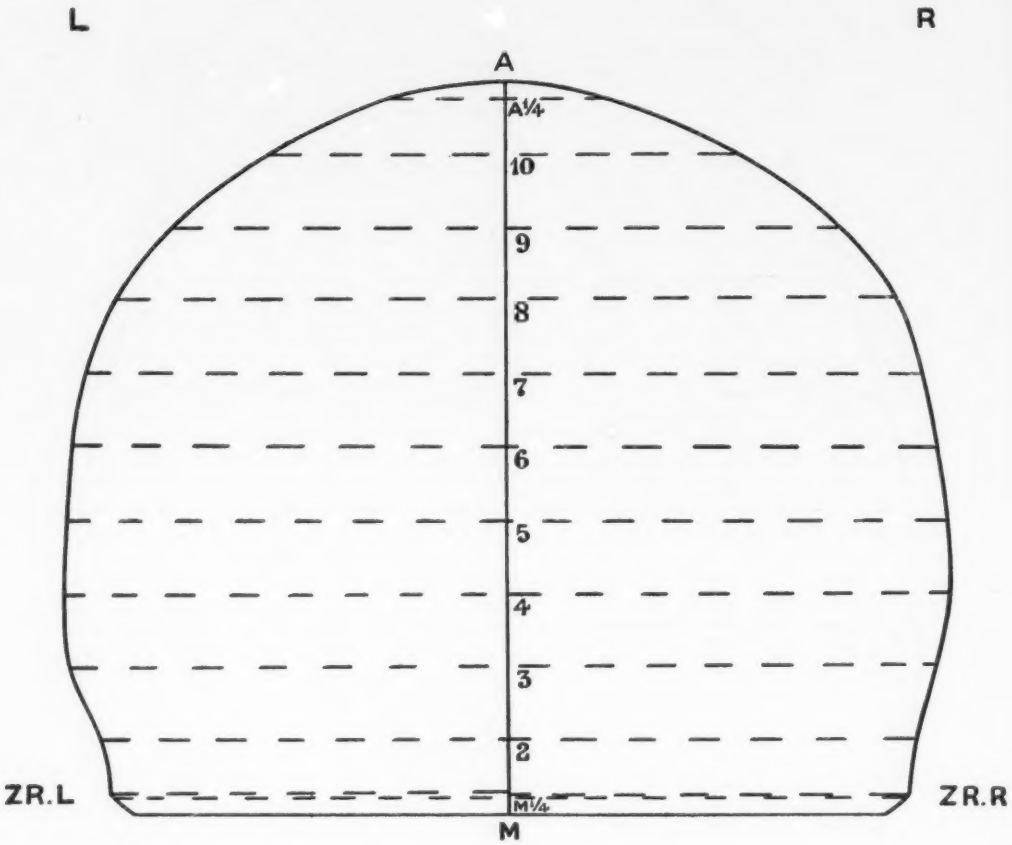


FIG. III Anglo-Saxon ♂ Transverse Type Contour

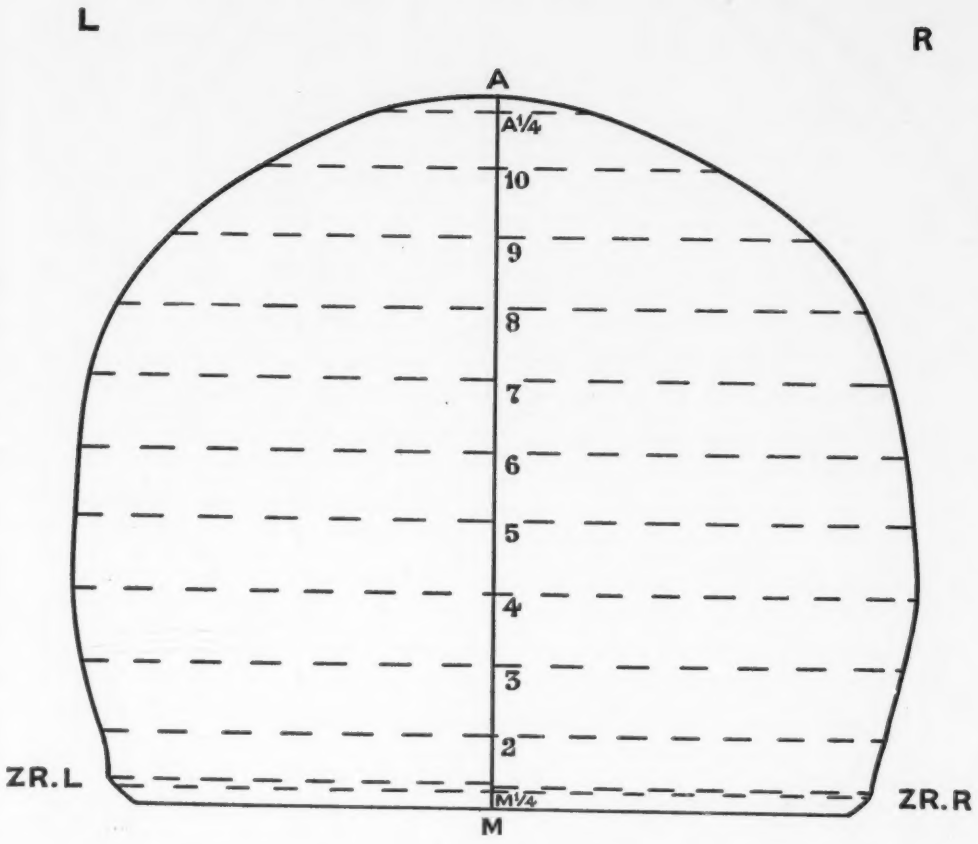


FIG. IV Anglo-Saxon ♀ Transverse Type Contour.

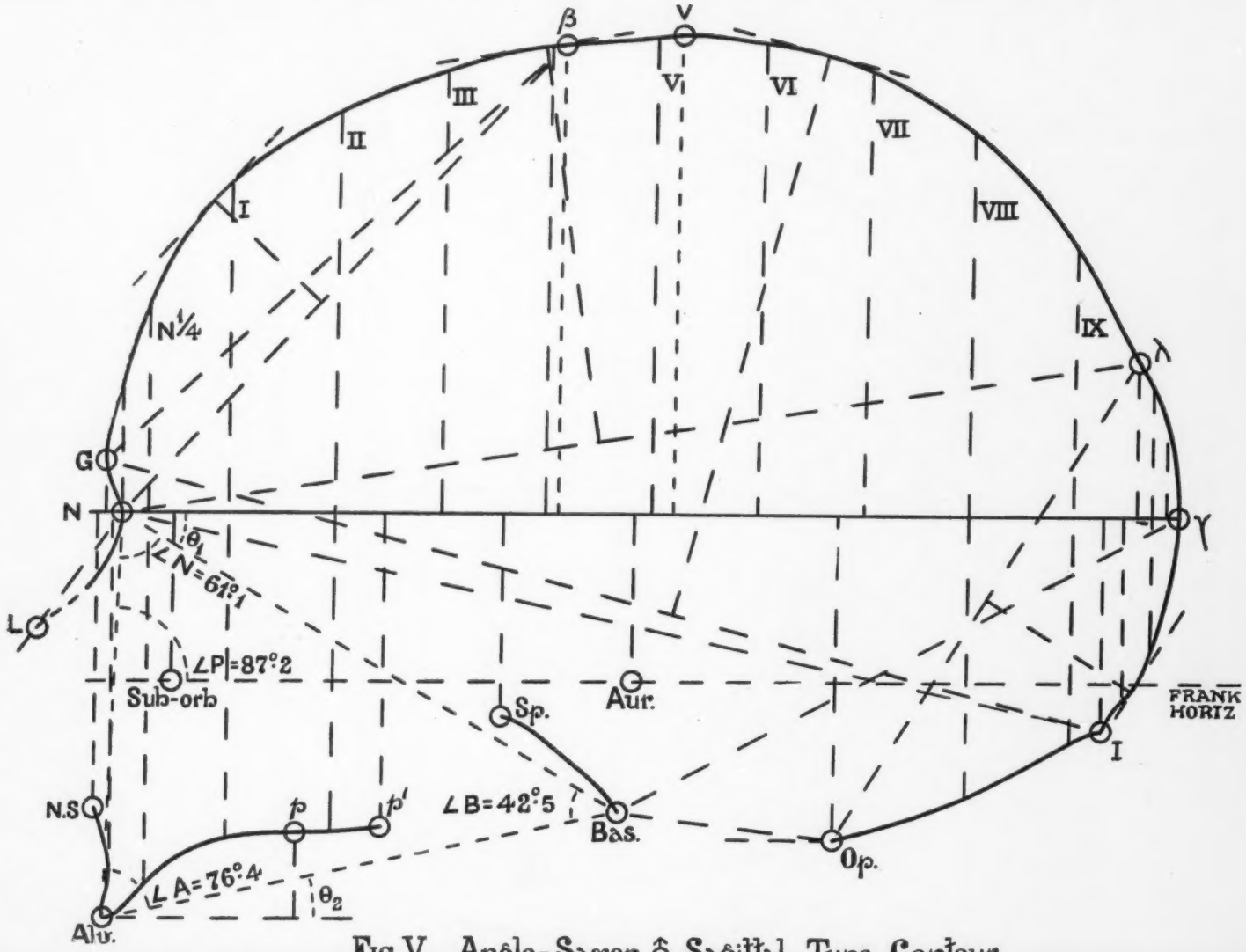
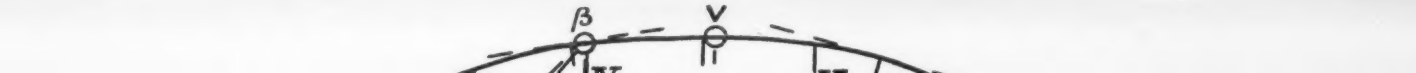


FIG. V Anglo-Saxon ♂ Sagittal Type Contour.



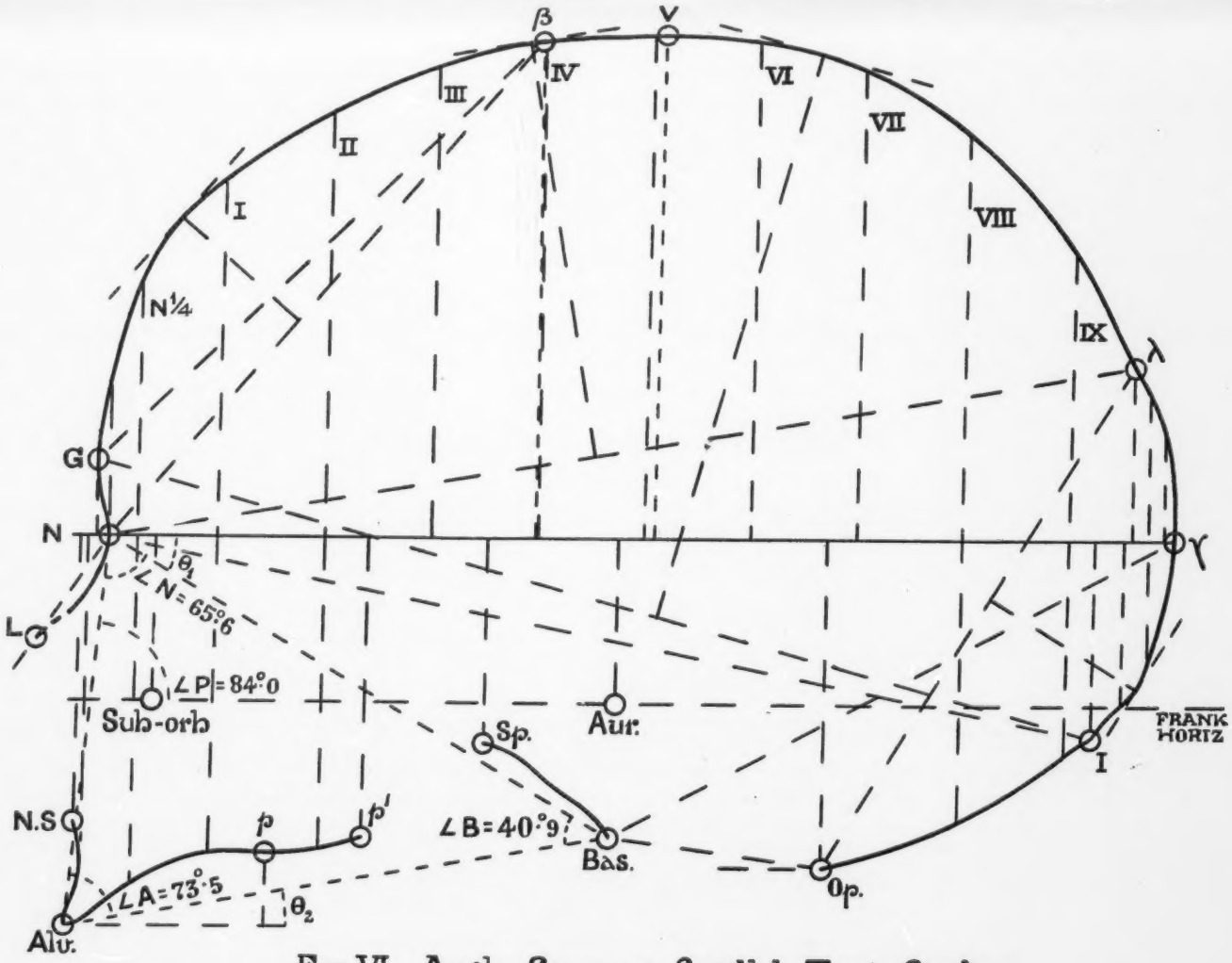


FIG. VI Anglo-Saxon ♀ Sagittal Type Contour.

TABLE XV.

Measurements of Anglo-Saxon Horizontal Type Contours.

	FO	*F¼R*	*F¼L*	*F½R*	*F½L*	*2R*	*2L*	*2½R*	*2½L*	*3R*	*3L*	*4R*	*4L*	*5R*	*5L*
♂	191·0 (43)	23·0 (42)	21·9 (42)	36·0 (42)	35·0 (39)	47·8 (41)	47·1 (39)	48·4 (41)	48·2 (38)	50·4 (38)	50·5 (36)	57·4 (29)	56·4 (29)	64·6 (33)	62·6 (31)
♀	178·2 (43)	23·3 (41)	20·7 (42)	34·8 (42)	31·9 (40)	46·1 (40)	44·3 (39)	48·2 (38)	46·9 (40)	50·6 (37)	49·4 (39)	56·0 (33)	54·5 (34)	61·1 (36)	60·0 (37)

	6R	*6L*	*7R*	*7L*	*8R*	*8L*	*9R*	*9L*	*10R*	*10L*	*O¼R*	*O¼L*	*TR*		*TL*	
													x	*y*	*x*	*y*
♂	69·6 (34)	67·1 (34)	70·5 (37)	67·8 (37)	67·4 (36)	65·0 (40)	59·7 (40)	57·9 (38)	46·0 (43)	43·3 (41)	26·5 (43)	23·4 (43)	20·1(42)	49·7(42)	21·3(39)	49·2(39)
♀	65·5 (39)	63·9 (39)	66·0 (39)	65·0 (39)	64·9 (41)	62·7 (39)	57·2 (41)	55·4 (39)	44·4 (42)	42·3 (40)	25·7 (42)	23·1 (41)	19·7(41)	48·1(41)	20·9(40)	47·0(40)

TABLE XVI.

Measurements of Anglo-Saxon Transverse Type Contours.

	MA	*1R=1L*	*M½R*	*M½L*	*2R*	*2L*	*3R*	*3L*	*4R*	*4L*	*5R*	*5L*	*6R*	*6L*
♂	114·0 (32)	58·4 (32)	61·9 (32)	61·5 (32)	63·4 (30)	63·6 (29)	66·4 (22)	68·4 (21)	68·8 (23)	69·2 (25)	68·4 (31)	68·5 (28)	67·2 (32)	67·4 (31)
♀	111·4 (31)	55·7 (31)	58·8 (31)	58·7 (31)	61·4 (31)	61·1 (31)	63·9 (28)	64·6 (25)	66·2 (27)	66·1 (28)	65·4 (29)	65·6 (30)	64·2 (30)	65·1 (30)

	7R	*7L*	*8R*	*8L*	*9R*	*9L*	*10R*	*10L*	*A¼R*	*A¼L*	*ZR, R*		*ZR, L*	
											y	*x*	*y*	*x*
♂	64·9 (32)	65·6 (31)	60·8 (32)	60·9 (30)	52·3 (32)	52·2 (30)	36·8 (32)	37·1 (32)	15·7 (32)	18·5 (32)	62·2 (32)	3·0 (32)	62·0 (32)	3·5 (32)
♀	62·2 (30)	63·8 (31)	58·2 (30)	59·2 (31)	49·9 (31)	51·0 (30)	34·9 (31)	36·5 (31)	15·1 (30)	18·8 (31)	59·2 (31)	3·3 (31)	59·9 (31)	3·7 (31)

TABLE XVII. *Measurements of Anglo-Saxon Sagittal Type Contours.*

TABLE XVII. *Measurements of Anglo-Saxon Sagittal Type Contours.*

	$N\gamma$	Ordinates above $N\gamma$												
		$0=N$	$N\frac{1}{4}$	1	2	3	4	5	6	7	8	9	$\gamma\frac{1}{4}$	$\gamma\frac{1}{8}$
♂	186·4 (42)	22·5 (42)	37·3 (42)	58·9 (41)	71·3 (41)	78·4 (41)	82·7 (41)	84·2 (40)	83·4 (41)	79·1 (42)	68·3 (41)	47·8 (42)	23·1 (42)	16·6 (42)
♀	176·1 (44)	27·0 (43)	43·6 (43)	59·3 (43)	71·3 (44)	77·8 (43)	81·7 (42)	83·4 (42)	82·6 (43)	78·0 (43)	67·5 (42)	48·2 (43)	24·5 (44)	18·6 (44)

	Ordinates below $N\gamma$							Vertex		β		Glabella	
	$N\frac{1}{4}$	1	2	8	9	$\gamma\frac{1}{2}$	$\gamma\frac{1}{4}$	x from N	y	x from N	y	x from N	y
♂	65·4 (19)	57·9 (20)	56·4 (17)	49·9 (41)	40·1 (41)	32·5 (41)	23·8 (41)	97·0 (40)	85·2 (40)	76·9 (41)	82·9 (41)	2·9 (42)	9·3 (42)
♀	56·7 (26)	52·0 (25)	51·5 (13)	46·9 (40)	35·6 (41)	27·2 (41)	20·3 (42)	89·5 (41)	83·9 (41)	70·2 (44)	82·1 (44)	2·3 (43)	12·4 (43)

	Occipital Pt.		λ		Sub-Orb.		Aur. Pt.		Opisthion		Inion		Basion	
	x from γ	y	x from γ	y	x from N	y	x from γ	y	x from γ	y	x from γ	y	from γ	from N
♂	0·5 (40)	−0·9 (40)*	7·2 (41)	27·2 (41)	9·0 (20)	29·7 (20)	95·9 (35)	29·3 (35)	60·0 (21)	58·2 (21)	13·3 (41)	37·8 (41)	111·4 (23)	102·7 (23)
♀	0·5 (43)	2·0 (43)	6·8 (44)	28·4 (44)	7·3 (28)	26·8 (28)	92·6 (33)	27·2 (33)	57·8 (30)	54·3 (30)	13·4 (41)	32·7 (41)	106·4 (18)	95·6 (18)

	Alv. Pt.		Nose					Palate				Frontal	
	from N	from Bas.	(i)	(ii)	(iii)	$\angle LN\gamma$	NL	P'		P		Max. Sub. to $N\beta$	
								x from N	y	x from Alv.	y	x from N	y
♂	71·8 (15)	92·8 (15)	0·8 (18)	3·1 (15)	6·3 (7)	125°·9 (2)	25·3 (2)	46·1 (16)	55·2 (16)	33·8 (15)	15·4 (15)	50·8 (41)	26·5 (41)
♀	65·2 (27)	91·0 (13)	1·0 (23)	3·4 (21)	6·3 (14)	124°·8 (6)	20·3 (6)	42·1 (13)	49·5 (13)	33·0 (21)	12·6 (21)	47·0 (42)	26·1 (42)

	Occipital Max. Sub. to λ Op.		Max. Sub. to $N\lambda$		Max. Sub. to GI		Sp.		Sub. from $\frac{1}{2}$ Bas. Sp. Chord		N. S.		Vert. Tang. to Alv. N. S. Arc	
	x from λ	y	x from N	y	x from G	y	x from N	y	x from Bas.	y	x from N	y	x from N	y
♂	49·6 (21)	30·4 (21)	85·0 (38)	71·1 (38)	104·0 (41)	102·6 (41)	67·1 (22)	35·6 (22)	13·5 (22)	1·7 (22)	4·5 (19)	52·0 (19)	1·8 (17)	62·6 (17)
♀	44·6 (29)	28·4 (29)	80·9 (44)	69·8 (44)	96·0 (38)	97·2 (38)	62·0 (22)	33·7 (22)	12·4 (18)	1·2 (18)	5·2 (27)	47·2 (27)	4·0 (25)	52·9 (25)

* The negative sign indicates that the occipital point is below the $N\gamma$ line.

TABLE XVIII. *Anglo-Saxon Mean Mandibular Measurements.*

	w_1	w_2	h_1	zz	$c_r c_r$	rb	rb'	G_2'	$c_y c_r$
♂	123·7 (25)	103·2 (45)	33·1 (40)	45·3 (57)	100·3 (27)	36·4 (58)	33·2 (61)	48·7 (43)	33·9 (40)
♀	116·6 (22)	96·0 (38)	30·5 (31)	44·1 (50)	93·2 (28)	34·6 (53)	31·0 (56)	47·5 (46)	33·0 (37)

	$g_o g_o$	$g_n g_o$ (*l*)	$g_n g_o$ (*r*)	$c_y l$	$c_y b$	$m_2 p_1$	$p_a d_t$	$p_a g_n$	$p_a d_f$
♂	100·4 (33)	87·9 (38)	89·9 (41)	21·7 (38)	9·5 (42)	28·1 (59)	28·2 (38)	7·1 (59)	25·3 (41)
♀	92·9 (35)	83·3 (38)	83·4 (40)	19·1 (35)	8·5 (42)	27·6 (57)	25·0 (30)	6·9 (55)	22·5 (33)

	$g_n d_f$	$p_a p_b$	$g_o p_a g_o$	ih	ih'	$c_r h$	$c_y h$	$d_t h$	$m_2 h$
♂	30·0 (41)	3·1 (6)	198·8 (39)	47·9 (51)	13·6 (35)	65·7 (48)	59·4 (44)	36·3 (40)	27·2 (51)
♀	27·5 (31)	4·2 (11)	187·2 (33)	43·0 (51)	12·7 (36)	59·2 (47)	54·7 (47)	33·0 (29)	24·4 (52)

	$p_1 h$	$c_p l$	rl	ml	$100\, c_r h/ml$	$100 c_r c_r/ml$	$100\, g_o g_o/c_p l$	$100\, rb'/rl$
♂	30·9 (54)	77·7 (42)	64·0 (45)	107·2 (31)	60·9 (27)	94·4 (15)	129·0 (32)	51·5 (45)
♀	27·8 (47)	74·6 (49)	59·1 (45)	104·2 (45)	58·3 (38)	91·7 (26)	126·2 (35)	53·0 (43)

	$100\, c_y b/c_y l$	$100\, g_o g_o/c_r c_r$	$100\, c_y h/c_r h$	$100\, ih'/c_y c_r$	$100 d_t h/c_r h$	$M \angle$	$R \angle$	$C \angle$
♂	44·0 (38)	99·3 (19)	89·9 (40)	40·4 (35)	55·2 (30)	120°·3 (47)	72°·0 (36)	68°·2 (32)
♀	43·7 (36)	99·3 (23)	89·6 (40)	39·0 (35)	56·4 (25)	122°·5 (49)	68°·2 (36)	70°·0 (25)

	$C' \angle$	$L \angle$	$L' \angle$	$F \angle$	$S \angle$	$G \angle$
♂	68°·3 (35)	82°·6 (6)	77°·9 (6)	87°·0 (6)	11°·5 (6)	68°·6 (31)
♀	70°·6 (32)	88°·0 (7)	87°·2 (7)	87°·3 (11)	14°·7 (6)	68°·5 (34)

APPENDIX I.

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APPENDIX II.

Individual Measurements of Anglo-Saxon Skulls in London Museums.

Individual measurements of all the adult and undeformed Anglo-Saxon skulls in the Museum of the Royal College of Surgeons (R.C.S. in tables), the British Museum (Natural History) (B.M.) and the London Museum (L.M.) are given in the following tables. A considerable number that had been posthumously distorted by earth pressure were not measured. Some measurements of nearly all the Royal College skulls have been given by Barnard Davis (19), Flower (27), Parsons (32 and 33) and Peake and Hooton (34). The sex was indicated in many cases by the artifacts interred with the body, and, where such evidence was available, the anatomical characters confirmed that estimate. Where there was no grave furniture the sex was judged by the present writer after assembling all the material in the particular museum. The divisions in the tables (Column 4) only correspond roughly with the Saxon kingdoms (see p. 76 of text). A. = Angle, J. = Jute, W.S. = West Saxon, S.S. = South Saxon. The abbreviations used in the references are: *J.R.A.I.* = Journal of the Royal Anthropological Institute, *Arch.* = Archaeologia: or Miscellaneous Tracts relating to Antiquity published by the Society of Antiquaries of London. The museum numbers preceded by B.D. are those of Barnard Davis' catalogue (19). The measurements and methods of measurement employed are precisely those of which a list is given by Hooke in the present issue of *Biometrika*, pp. 15—16, with the single addition of G_1'', a palate length measured from the alveolar point to the tip of the posterior nasal spine. The greater number of the remarks relating to cranial anomalies usually given by workers in the Biometric Laboratory have had to be omitted as nearly all the skulls are defective. Many of the more common anomalies were, however, found. Unless otherwise stated a specimen is fully adult, showing no signs of aging. The teeth, often considerably worn, gave the impression of being better preserved than those of 17th century Londoners. There were several cases of carious teeth. Out of 127 skulls there were 2 evident and 2 rather doubtful cases of trepanation, all 4 being on ♂ skulls. One ♀ skull from West Harnham, Wilts., now in the Royal College of Surgeons, appears to be a clear case of artificial deformation, though the only one found among Anglo-Saxon skulls. It is figured by Barnard Davis (19, p. 30). Several skulls bore bluish-green stains evidently made by the copper in metal artifacts buried with the body.

APPENDIX II.

Lengths

Museum	Graveyard and Reference	Mus. No.	Div.	Sex	*F*	*L'*	*L*	*B*	*B'*
B.M.	Sleaford, Lincs. *Arch.* L. 1887	3	A.	♂	196?	—	200?	140?	94·2
,,	,, ,,	5	,,	♂	186·5	—	190	144	103·5
,,	,, ,,	10	,,	♂	195·5	—	197	141·5?	97·9
,,	,, ,,	11	,,	♂	198?	—	204?	142?	100·3
,,	,, ,,	13	,,	♂	199	—	202·5	133?	98·5
,,	,, ,,	14	,,	♂?	198?	—	—	—	—
,,	,, ,,	17	,,	♂?	185	—	188	137·5	98·1
,,	,, ,,	18	,,	♂?	185·5?	—	185·5?	136?	96·0
R.C.S.	Linton Heath, Cambs.	B.D. 40	,,	♂	184	185	184·5	134·5	94·9
,,	,, ,,	B.D. 672	,,	♂	194·5	196·5	194	145	96·0
,,	Sedgeford Hall, Norfolk	317·21	,,	♂	183	183	184	135?	96·7
,,	Near Driffield, Yorks.	B.D. 581	,,	♂	179·5	179·5	180	136	91·5
,,	Linton Heath, Cambs.	281[1]	,,	♂	193	196	195	154	100·0
,,	Ozingell, Kent	B.D. 1052	J.	♂	—	—	—	146·5	90·6
,,	Strood, Kent. *Coll. Antiq.* v. p. 129	B.D. 674	,,	♂	185	—	191	146·5	99·8
,,	Wye, Dover	317	,,	♂	196	200·5?	201	142	100·1
,,	Ash, Kent	317[1]	,,	♂	192	196·5	195	143·5	100·2
,,	Folkestone. *J.R.A.I.* XLI. 1911, p. 101	368·1	,,	♂?	191	—	194	142	100·1
,,	Pegwell Bay, Kent	374·1	,,	♂?	183	184	183·5	145	106·1
,,	Greenhithe, Kent	373·1	,,	♂	189	196	189·5	147	93·9
,,	Near Canterbury	320·2	,,	♂	—	—	—	136?	94·9
,,	Broadstairs. *J.R.A.I.* XLIII. 1913, p. 550	366·12	,,	♂	177?	—	181?	—	97·7
,,	Pegwell Bay, Kent	371·12	,,	♂	179	182	181	140	95·1
,,	Newbury. *J.R.A.I.* XLV. 1915, p. 92	350·22	W.S.	♂	192·5?	194·5?	193?	139·5?	92·1?
,,	,, ,, ,,	350·41	,,	♂	—	—	—	—	82·9?
,,	West Harnham, Wilts.	B.D. 124	,,	♂	181	180·5	180	148	100·1
,,	Long Wittenham, Berks.	B.D. 588	,,	♂?	189·5?	—	193·5?	143	—
,,	,, ,,	B.D. 589	,,	♂	180·5	—	181·5	141	100·3
L.M.	Mitcham, Surrey	19	S.S.	♂	180	—	182·5	135·5?	—
,,	,,	26	,,	♂	—	—	—	140	—
,,	,,	16 *a*	,,	♂?	189	—	191·5	139·5	95·5
,,	,,	23	,,	♂	189	190	190	138	105·8
R.C.S.	,,	110	,,	♂	192·5	196?	196	139·5	96·5
,,	,,	115	,,	♂	186	188·5?	188	145	101·6
,,	Cane Hill	395·31	,,	♂	189	191	192	141	97·9
,,	,,	395·32	,,	♂	183	—	187	137?	98·6
,,	Bartlow, Essex	320	,,	♂	—	—	—	139	93·8
,,	Cane Hill	395·33	,,	♂?	—	—	—	—	89·8

B.M.	Sleaford, Lincs. *Arch.* L. 1887	28	A.	♀	173	170·5	173	143?	87·9
,,	,, ,,	25	,,	♀	189·5	185	189	137	95·9
,,	,, ,,	22	,,	♀	177·5?	177?	176?	132?	91·2
,,	,, ,,	21	,,	♀?	—	—	—	135?	—
,,	,, ,,	20	,,	♀	181	180	182·5	136·5?	95·8
R.C.S.	Linton Heath, Cambs.	B.D. 41	,,	♀	182	—	183·5	134	89·0
,,	,, ,,	B.D. 42	,,	♀	175·5	176	174·5	134	103·6
,,	,, ,,	B.D. 44	,,	♀	171·5	172·5	171·5	137·5	88·1
,,	,, ,,	B.D. 45	,,	♀	178?	180·5	180·5?	128·5?	93·9
,,	,, ,,	B.D. 49	,,	♀	173	175·5	176	130·5	93·5
,,	Sedgeford Hall, Norfolk	317·2	,,	♀	178·5?	178·5?	178?	126·5?	87·4
,,	Linton Heath, Cambs.	319	,,	♀	170·5	171	172	125	92·3
,,	Folkestone. *J.R.A.I.* XLI. 1911, p. 101	332·22	J.	♀	—	—	—	—	99·4?
,,	,, ,, ,,	369·1	,,	♀	177?	176·5?	176?	125?	96·6
,,	Broadstairs. *J.R.A.I.* XLIII. 1913, p. 550	366·14	,,	♀	181	179	181	137	95·4
,,	,, ,, ,,	366·15	,,	♀	174	—	178	130	84·1
,,	Brighthampton, Oxon.	281·3	W.S	♀	188·5	189·5	188·5	140·5	96·8
,,	,,	281·2	,,	♀?	174	176?	176	142	95·2
,,	Newbury. *J.R.A.I.* XLV. 1915, p. 92	350·23	,,	♀	—	—	—	—	—
,,	,, ,, ,,	350·26	,,	♀	179?	—	179·5?	136·5?	98·9
,,	,, ,, ,,	350·28	,,	♀	181?	—	181·5?	135?	95·3
,,	,, ,, ,,	350·29	,,	♀	177	178·5	176·5	133·5	102·5
,,	,, ,, ,,	350·31	,,	♀	185?	—	185?	131·5?	96·8?
,,	,, ,, ,,	350·32	,,	♀	—	—	177?	138?	99·5
,,	,, ,, ,,	350·35	,,	♀	186	186?	186·5	137	96·1
,,	,, ,, ,,	350·43	,,	♀	183·5?	—	186?	—	90·5
,,	West Harnham, Wilts.	B.D. 127	,,	♀	189	190	189·5	136	95·2
,,	Long Wittenham, Berks.	B.D. 587	,,	♀	178·5?	179?	179?	136?	93·1
L.M.	Mitcham, Surrey	12	S.S.	♀	—	—	—	125·5?	—
,,	,,	18	,,	♀	186?	—	188?	125?	94·0?
,,	,,	20	,,	♀	171?	—	171?	128?	91·8
,,	,,	22	,,	♀	181	184·5	181	138?	96·2
,,	,,	25	,,	♀	187·5?	—	189	139	98·8
R.C.S.	,,	346·71	,,	♀?	189	191	190	140	95·9
,,	,,	118	,,	♀	183	182	181	136	90·5
,,	,,	108	,,	♀	177	179?	178·5	136	92·1

Lengths							Arcs								Form
L	*B*	*B′*	*H*	*H′*	*OH*	*LB*	*Q*	*Q′*	*S*	S_1	S_2	S_3	S_3'	*U*	*fml*
200?	140?	94·2	—	—	—	—	—	311?	385·5	126·5	125·5	133·5	97·0	541	—
190	144	103·5	—	—	—	103·5	—	—	—	—	—	115·5	96·5	537	41·3
197	141·5?	97·9	—	—	—	—	—	—	—	123?	141?	125?	96·6	545?	—
204?	142?	100·3	—	—	—	—	—	—	—	131	135?	113?	84·0?	—	—
202·5	133?	98·5	137?	137?	108·7	116·5?	—	—	383·5	128	131·5	124	98·8	547?	—
—	—	—	—	—	—	—	—	—	—	—	135·5	—	—	—	—
188	137·5	98·1	—	—	—	—	—	—	368	131·5	121	115·5	98·2	—	—
185·5?	160?	96·0	—	—	—	—	—	—	—	130	134?	—	—	—	—
184·5	134·5	94·9	132	132·5	110·5	98·0	300·5	302·5	367·5	123	126	118·5	96·8	516?	40·2
194	145	96·0	138·5	138	113·1	108·9	311	318	383·5	136·5	123	124	98·7	546	39·3
184	136?	96·7	136·5	135	114·0	98·8	301	—	373·5	125	130·5	118	96·3	—	37·6
180	136	91·5	125	125	108·1	94·3	298·5	299	370	129	128	113	93·2	504	31·5
195	154	100·0	142	143	121·9	102·0	336·5	336	394	133	129	132	107·0	588	38·0
—	146·5	90·6	—	—	111·7	—	304	306	—	135	128?	—	113·2?	—	—
191	146·5	99·8	—	133	—	105·1	—	—	365·5	126	124	115·5	94·1	533·5	42·9
? 201	142	100·1	148?	147	123·9?	109·3?	330?	331	399	136	134·5	128·5?	105·6?	547	37·8
195	143·5	100·2	135	135	116·0	105·6	319·5	321	388·5	134	133·5	121	99·2	544	37·7
194	142	100·1	—	127·5	—	101·5	—	—	376·5	130	124	122·5	93·1	537	34·3
183·5	145	106·1	—	—	—	97·2	—	—	—	—	—	121	92·0	538?	29·8
189·5	147	93·9	136	135	114·0	102·2	310·5	311	389·5	132	116	141·5	111·8	549	40·3
—	136?	94·9	—	133?	—	107·3	—	—	—	122	—	—	—	—	—
181?	—	97·7	—	137?	—	102·8?	—	—	367?	122	—	—	—	—	—
181	140	95·1	140·5	139	117·1	102·2	312·5	314	373	131	124·5	117·5	96·4	520	38·1
? 193?	139·5?	92·1?	—	135?	—	—	309?	308?	389?	—	—	126?	105·2?	540?	36·4
—	—	82·9?	—	—	—	—	—	—	—	—	—	—	—	—	—
180	148	100·1	132	132	113·0	93·4	315	318	371·5	138	118	115·5	98·2	528	41·0
193·5?	143	—	—	—	—	110·8?	—	—	370·5	131	124	115·5	95·0	—	36·7
181·5	141	100·3	—	129·5	—	95·2?	—	—	364·5	122·5	122	120	94·6	519	—
182·5	135·5?	—	—	—	—	—	—	310?	—	127	123	—	—	—	—
—	140	—	134?	—	—	—	—	301·5?	—	—	123	—	—	—	—
191·5	139·5	95·5	—	—	107·5?	—	—	312?	—	—	121?	137·5?	107·0?	529?	—
190	138	105·8	142	140?	119·8	108·0	319	316	—	131	127	—	—	537	—
196	139·5	96·5	146?	145	122·3?	109·5	325?	329	393	135	136	122	102·0	547?	39·1
? 188	145	101·6	—	—	116·1?	—	320?	324	379	130	129	120	95·6	537	—
192	141	97·9	144?	145?	117·9	103·5?	319	319	388	130	138	120	98·1	538	37·5
187	137?	98·6	—	129	—	105·7	—	—	—	123·5	112?	—	—	—	—
—	139	93·8	—	—	—	—	—	—	—	121·5	—	—	—	—	—
—	—	89·8	—	—	—	—	—	—	—	126?	—	—	—	—	—

173	143?	87·9	133·5	133	—	90·9	—	—	375·5?	128	126·5	121?	103·4	—	31
189	137	95·9	—	—	—	—	—	—	375·5	126·5	131	118	94·0	522?	—
176?	132?	91·2	—	—	—	—	—	—	353	121	124	108?	88·0?	—	—
—	135?	—	—	—	—	—	—	—	—	—	—	109·5	92·4	—	—
182·5	136·5?	95·8	—	—	110·6	—	—	—	—	123	127	—	—	510?	—
183·5	134	89·0	—	127·5	—	95·7	—	—	—	125·5	125	—	—	512	—
174·5	134	103·6	129	127·5	104·9	96·3	291·5	295	366	131	106·5	128·5	105·0	500	31
171·5	137·5	88·1	—	—	116·0	—	313	315	358	115·5	114	128·5	106·0	499·5	—
180·5?	128·5?	93·9	122·5	122	104·8	101·0	288?	292?	350	123·5	118	108·5	89·5	508?	35
176	130·5	93·5	127	126	108·8	93·1	291	291	366·5	113	116	137·5	107·0	491	29
? 178?	126·5?	87·4	—	—	110·0?	—	291·5?	295?	—	121·5	125·5	—	—	495?	—
172	125	92·3	125	123·5	105·8	94·2	282·5	281	335·5	112·5?	125?	98?	83·5?	480·5	40
—	—	99·4?	—	—	—	—	—	—	—	112?	—	—	—	—	—
? 176?	125?	96·6	—	—	109·0?	—	294?	296?	366·5	125?	120?	121·5	105·1	498?	—
181	137	95·4	—	—	118·0	—	319	319·5	376·5	130	126·5	120	99·9	510	—
178	130	84·1	—	—	—	—	—	—	—	120	122?	—	—	—	—
188·5	140·5	96·8	—	—	—	94·2	—	—	—	—	—	122·5?	97·6?	532?	38
176	142	95·2	—	—	106·3?	—	297	297·5	371	130?	124?	117?	98·2?	507	—
—	—	—	—	—	—	93·2?	—	—	376?	127?	134?	115?	90·5?	—	33
179·5?	136·5?	98·9	—	—	—	—	—	—	—	123?	132?	—	—	511?	—
181·5?	135?	95·3	—	—	—	—	—	—	—	122?	123?	—	—	—	—
176·5	133·5	102·5	127·5	128	104·6	96·7	293·5	293	354·5	122·5	117	115	93·9	505	3
185?	131·5?	96·8?	—	—	—	—	—	—	370?	125?	123?	122?	102·7?	516?	—
177?	138?	99·5	—	—	—	—	—	—	373?	141?	120?	112?	98·3?	513?	—
186·5	137	96·1	—	—	111·2?	—	306?	311?	367?	120	114?	133?	102·2?	521?	—
186?	—	90·5	—	—	—	—	—	—	—	—	—	117?	96·1?	513?	—
189·5	136	95·2	136	136·5	113·9	107·2	308	308	373·5	128	125	120·5	99·1	525	3
179?	136?	93·1	131?	132?	108·9?	94·1	294?	292	—	126·5	123	—	—	507?	—
—	125·5?	—	—	—	—	—	—	—	—	143	—	—	—	—	—
188?	125?	94·0?	—	—	—	—	—	—	—	127	123?	—	—	511?	—
171?	128?	91·8	—	—	—	—	—	—	—	120?	133?	—	—	490?	—
181	138?	96·2	134?	133?	112·3?	93·9	—	310?	—	127	121	122?	97·0?	516	3
189	139	98·8	—	133?	—	100·4?	—	—	—	130	137·5	—	—	527?	—
190	140	95·9	134	133	115·2	100·9	315·5	315	391·5	137·5?	131?	123?	103·3	530	3
181	136	90·5	—	—	113·0	—	302	304	381	124	141	116	94·2	509	—
178·5	136	92·1	132?	130·5?	110·0?	96·6?	301?	301?	360·5	118	123·5	119	98·9	503	3

INDIVIDUAL MEASUREMENTS O

		Foramen		Face					Nose									Orbits		
s′	*U*	*fml*	*fmb*	*G′H*	*GL*	*GB*	*J*	*PH*	*NH, R*	*NH, L*	*NH′*	*NB*	*DS*	*DC*	*DA*	*SS*	*SC*	O_1R	O_1L	O_2R
7·0	541	—	—	—	—	—	—	20·0	—	—	—	—	—	—	—	—	—	—	—	—
6·5	537	41·3	34·8	70·1	92·7	93·8	—	19·9	50·6	51·6	49·5	24·6	—	22·7	—	—	5·6	43·0	43·4	33·6?
6·6	545?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4·0?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4·0	8·6	—	—	—
8·8	547?	—	—	78·9?	106·4?	—	—	20·3	59·7?	59·2?	57·8?	24·2	13·4?	23·1?	39·5?	5·4?	11·6?	—	—	40·8
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8·2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6·8	516?	40·2	29·3	70·1?	88·1?	—	—	20·1?	48·6	48·1	49·1	25·4	11·8	22·9	35·9	2·0	7·7	43·3	—	30·0
8·7	546	39·3	31·0	76·1?	98·4	95·2?	138·0	18·6?	56·0	55·0	58·0?	29·1	—	23·7	—	—	10·1	44·5	44·8	33·2
6·3	—	37·6	28·7	64·5	89·9	91·5	—	18·5	46·7	46·6	46·4	23·0	11·3	24·0	25·3	4·4	10·0	42·6	41·9	36·1
3·2	504	31·5	25·6	69·5	83·5	83·6	120·0	24·0	47·3	47·1	45·1	21·6	9·8	19·0	29·0	3·8	9·0	43·0	42·8	36·1
7·0	588	38·0	31·1	67·1	91·8	95·4	142·2	17·9	49·5	48·5	49·2	23·8	13·2	25·0	39·2	3·7	11·0	44·6	43·6	32·8
3·2?	—	—	—	73·1	—	104·3	139·1	18·3	—	56·1	55·8	23·3	12·4?	16·2?	21·3?	4·3	7·9	43·1	40·8	31·9
4·1	533·5	42·9	35·7	—	91·1?	103·3	136·7?	26·0	—	—	—	25·6	—	—	—	—	—	—	—	—
5·6?	547	37·8?	34·5	71·6?	97·0?	—	—	—	—	—	—	—	—	—	—	—	—	40·8?	—	31·8?
9·2	544	37·7	29·8	75·2	99·8	91·9	129·1	24·2	52·0	51·8	53·1	23·7	12·8	21·4	27·0?	6·3	10·0	45·5	44·2	34·9
3·1	537	34·2	29·0	—	—	—	—	—	—	—	—	—	—	—	—	5·3	9·5	—	—	—
2·0	538?	29·8	27·1	—	—	98·0	136·0?	—	56·0	55·9	55·0	27·7	13·3	25·2	39·5	4·4	10·7	40·7	40·7	32·7
1·8	549	40·3	35·8	75·6	91·0	92·8	136·2	19·7	56·3	55·4	57·1	26·5	9·7	18·5	21·0	4·6	8·8	42·0	42·7	31·2
—	—	—	—	—	—	—	—	—	—	—	—	—	15·2	21·5	30·5	4·9	8·2	—	—	34·2?
—	—	—	—	—	—	—	—	20·8?	—	—	—	—	—	—	—	—	—	—	—	—
6·4	520	38·2	27·6	—	—	92·5	135·1	—	52·2	51·7	54·7	24·8	13·0	22·2	37·5	5·8	11·4	42·7	40·5	34·1
5·2?	540?	36·1	29·9	67·7?	94·9?	103·5?	—	15·0	53·7?	53·0?	55·2?	25·8?	—	—	—	4·3?	8·9	43·0	—	31·8
—	—	—	—	—	—	—	—	17·8?	—	—	—	—	—	—	—	—	—	—	—	—
8·2	528	41·9	31·5	67·7	84·1	91·9	130·1?	16·4	50·4	50·4	52·0	25·7	—	—	—	—	—	43·9	43·0?	35·3
5·0	—	36·2?	—	72·1?	98·3?	99·1?	—	18·5	54·9?	53·7?	58·0?	27·2?	—	—	—	—	—	—	—	—
4·6	519	—	—	—	—	—	—	19·5	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	17·9	—	—	—	—	—	—	—	2·1	7·1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7·0?	529?	—	—	—	—	—	—	25·1	—	—	—	—	—	—	—	—	—	—	—	—
—	537	—	—	76·1?	95·9	92·6	134·5?	19·4?	55·2	54·9	56·7	—	—	—	—	4·9	10·8	—	44·5	38·2
2·0	547?	39·9	34·0	73·8?	105·4	—	—	22·7?	52·0	54·1	51·9	26·8	17·0	25·3	46·8	5·3	9·9	43·7	—	32·2
5·6	537	—	—	68·9?	—	92·8?	—	18·3?	51·1?	52·3?	50·7?	—	—	—	—	—	—	—	—	32·0?
8·1	538	37·0	—	—	—	98·6	—	—	52·9	54·6	52·9?	23·5	—	—	—	—	—	42·3?	43·3?	36·2?
—	—	—	—	73·3	101·6	93·1	—	20·0	54·0	53·3	53·2	26·0	10·7	21·2	22·0	2·8	6·6	42·1	42·0	35·6
—	—	—	—	66·4	—	86·5	119·3?	17·9	50·2	49·8	50·3	23·3	13·2	23·1	29·1	6·1	9·4	45·0	44·5	34·2
—	—	—	—	69·7?	—	—	—	18·2?	51·9	—	53·2	25·8?	—	21·5	—	—	—	40·1?	40·8	32·1?

INDIVIDUAL MEASUREMENTS OF

93·4	—	31·5	23·1	54·5	87·1	83·4	118·0?	15·2	38·1	38·7	38·6	19·0	9·1	16·9	28·7	4·1	11·0	43·0	40·6	30·6
94·0	522?	—	—	75·0?	—	89·2?	119·0?	21·3	55·3?	53·8	54·5?	—	—	—	—	—	—	—	—	—
88·0?	—	—	—	—	—	—	—	16·9?	—	—	—	—	—	—	—	—	—	—	—	—
92·4	—	—	—	—	—	—	—	14·5	—	—	—	—	—	—	—	—	—	—	—	—
—	510?	—	—	64·3?	—	94·1	—	17·1	46·6?	46·5?	46·3?	—	—	—	—	—	—	—	37·0?	28·7?
—	512	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6·1	8·9	—	—	—
95·0	500	31·3	28·1	63·4	90·7	94·7?	123·2?	13·8	47·8	48·9	48·4	26·9	13·9?	27·2?	39·6?	3·7	12·0	41·0	40·8	31·9
96·0	499·5	—	—	66·7?	—	86·6	—	—	49·5	49·1	50·4	25·6	—	18·0	—	—	9·1	40·4	39·1	30·1
89·5	508?	35·1	29·3	69·0	94·8	84·3	—	16·5	52·0	52·2	52·8?	24·3	13·0	18·2	30·9	2·4	3·6	41·2	39·9	32·3
97·0	491	29·9	30·2	62·1	93·0	84·3	125·0?	17·2	44·0	45·0	45·3?	24·5	12·6	20·6	29·2	3·0	8·1	42·0	41·4	31·2
—	495?	—	—	57·4	—	86·0?	—	11·9?	45·1	41·9	45·3?	23·5	—	—	—	—	6·5?	37·7	38·5	32·6
83·5?	480·5	40·7	29·3	60·9?	86·3?	83·7?	124·0?	13·7?	49·9?	47·8?	47·5	—	—	21·0?	—	—	—	42·3?	41·3?	33·1?
—	—	—	—	—	—	88·7?	—	—	50·0?	48·8?	—	24·1?	11·2	21·0	34·5	3·9	8·9	43·2	42·8	34·9
95·1	498?	—	—	67·5?	—	—	125·1?	15·8	47·9?	47·2?	52·0	—	—	—	—	—	—	40·6?	42·5?	34·3?
99·9	510	—	—	68·0	—	89·1?	129·2	18·7?	49·3	50·1	50·4?	23·5	—	20·6?	—	—	—	42·8	42·5	34·1
—	—	—	—	66·4?	—	92·0?	—	18·0?	48·9	49·2	49·5	21·8	12·5	18·3	36·6	4·3	8·2	41·7	42·2	33·5
97·6?	532?	38·9	29·7	61·5	93·8	90·4	122·2	14·8	44·1	43·6	46·7	21·9	13·5	19·0	25·1	4·6	9·7	41·1	40·1	30·4
98·2?	507	—	—	69·7	—	83·1?	—	18·2	—	—	—	—	—	—	—	3·4	6·5	—	39·0	—
90·5?	—	32·5	23·1	62·4	92·7?	—	—	19·8	43·0	42·6	42·5	23·1	12·0	18·5	32·0	3·9	8·2	—	42·3?	—
—	511?	—	—	—	—	—	—	20·2?	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	16·5?	—	—	—	—	—	—	—	—	—	—	—	—
93·9	505	35·2	24·2	66·0	91·2	92·4	125·1?	18·1?	49·3	49·4	49·3?	28·6	13·3	28·4	40·5	4·3	11·9	42·4	40·8	33·8
102·7?	516?	—	—	67·2?	—	87·1	—	16·3?	51·7	49·8	51·4?	22·7	13·8?	22·1?	36·5?	5·1	8·7	41·2?	40·6	33·7?
98·3?	513?	—	—	58·9?	—	97·8?	126·3?	11·8	47·0?	48·1?	47·5?	—	—	—	—	—	—	41·4?	—	33·8?
102·2?	521?	—	—	73·9	—	92·9?	130·0?	16·5?	55·2	—	56·9?	—	—	24·2?	—	—	14·5?	42·8	43·9	35·5
96·1?	513?	—	—	63·4?	—	92·9?	—	17·7	45·9?	45·9?	45·9?	—	—	—	—	—	—	—	41·8	30·1?
99·1	525	37·1	32·0	75·6	103·0	101·9	124·5?	26·2	50·1	49·9	49·4	25·9	13·5?	21·0?	35·5?	2·4	7·6	44·0	43·0	37·5
—	507?	—	—	62·0?	95·2?	91·9	126·6?	16·9?	46·3	46·7	44·6	23·9	11·5?	21·0	32·5?	2·9	6·4	42·5	42·0	34·2
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3·2	8·0	—	—	—
—	511?	—	—	74·8	—	—	—	19·3	54·9	54·9	55·4	27·5	12·2	24·0	28·0	3·9	8·7	—	43·0	37·1
—	490?	—	—	70·8?	—	93·0?	—	23·7	48·7?	49·2?	47·1?	—	—	—	—	—	—	—	—	—
97·0?	516	35·5	29·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	42·0	—	32·7
—	527?	—	—	63·8	102·5	101·5	138·0?	15·0	48·6	49·3	47·9	27·2?	10·1?	26·4?	37·0?	3·0	7·8	41·1	41·0	35·3
103·3	530	33·8	30·1	68·0	95·2	87·2	118·8	19·1	50·2	50·6	48·1	23·0	11·8	20·0	24·0	—	—	41·9	40·7	32·4
94·2	509	—	—	57·7	—	87·1	121·3?	12·1?	43·8	44·2	45·1	24·9	9·2?	20·9?	31·0?	2·4	8·6	41·3	42·3	29·2
98·9	503	38·0	31·2	66·8?	90·0?	—	—	17·2	49·1	—	49·7	—	—	—	—	—	7·1	38·8	—	33·7

MENTS OF MALE ANGLO-SAXON SKULLS IN LONDON MUSEUMS.

Orbits				Palate													
O_1L	O_2R	O_2L	$O_1'R$ or L	G_1	G_1'	G_1''	$G_2=EB$	EH	$100\frac{B}{L}$	$100\frac{H'}{L}$	$100\frac{B}{H'}$	$100\frac{(B-H')}{L}$	$100\frac{H}{L}$	$Oc.I.$	$100\frac{fmb}{fml}$	100
—	—	—	—	47·5	43·2	53·0	—	—	70·0?	—	—	—	—	53·7	—	
43·4	33·6?	33·9	40·4	48·1	43·4	51·9	39·1	11·9	75·8	—	—	—	—	60·2	84·3	7
—	—	—	—	—	—	—	—	—	71·8?	—	—	—	—	55·4?	—	
—	—	—	—	—	—	—	—	—	69·6?	—	—	—	—	54·2?	—	
—	40·8	40·2?	—	53·5	47·7	57·7	42·1	13·8	65·7?	67·7?	97·1?	−2·0?	67·7?	56·8	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	39·0	12·3	73·2	—	—	—	—	62·1	—	
—	—	—	—	—	—	—	38·7?	—	86·3?	—	—	—	—	—	—	
—	30·0	30·9	40·5	48·1	44·3	51·6	39·3	6·6	72·9	71·7	101·7	+1·2	71·7	58·4	72·9	
44·8	33·2	34·1	41·3	52·2?	48·6?	57·1?	40·3	12·1?	74·7	71·1	105·1	+3·6	71·3	56·8	78·9	79
41·9	36·1	35·9	38·4	45·5	43·0	49·0	40·0	12·5	73·9?	73·4	100·7?	+0·5?	74·2	58·4	76·3	79
42·8	36·1	35·6?	41·9	47·1	43·0	49·9	37·5	13·1	75·5	69·4	108·8	+6·1	69·5	59·2	81·3	83
43·6	32·8	32·8	41·0	50·0	45·9	53·4	46·2	15·2	79·0	73·3	107·7	+5·7	72·8	57·8	81·8	76
40·8	31·9	32·9	39·6	—	—	—	—	—	—	—	—	—	—	—	—	79
—	—	—	—	52·9	47·8	57·8	45·1?	11·4?	76·7	69·7	110·1	+7·0	—	58·2	83·2	
—	31·8?	—	—	51·1	46·9	55·0	44·4	14·2	70·6	73·1	96·6	−2·5	73·7?	58·8?	91·3?	
44·2	34·9	34·0	41·9	52·3	47·4	57·5	40·1	13·2	73·6	69·1	106·5	+4·5	69·2	58·6	79·0	81
—	—	—	—	—	—	—	—	—	73·2	65·7	111·4	+7·5	—	54·8	84·8	
40·7	32·7	31·9	39·2	48·7	46·2	—	40·0	12·7	79·0	—	—	—	—	54·8	90·9	
42·7	31·2	32·1	—	50·0	48·5	53·8	44·4?	—	77·5	71·3	108·9	+6·2	71·8	56·4	88·8	81
—	34·2?	—	—	—	—	—	—	—	—	—	102·3?	—	—	—	—	
—	—	—	—	48·1?	46·8?	50·8	35·0?	—	—	75·7?	—	—	—	—	—	
40·5	34·1	34·1	40·3	46·0?	42·7?	—	—	—	77·3	76·8	100·7	+0·5	77·6	58·7	72·3	
—	31·8	30·8	—	—	—	—	48·0	—	72·3?	69·3?	104·3?	+3·0?	—	60·2?	82·8	65
—	—	—	—	—	—	—	39·1?	—	—	—	—	—	—	—	—	
43·0?	35·3	33·0	41·4	45·7	40·0	50·2	40·2	11·7	82·2	73·3	112·1	+8·9	73·3	62·1	75·2	73
—	—	—	—	—	—	—	43·7	—	73·9?	—	—	—	—	58·9	—	72
—	—	—	—	54·1	50·0	57·7	41·5	10·5	77·7	71·3	108·9	+6·4	—	56·3	—	
—	—	—	—	—	—	—	42·1	—	74·2?	—	—	—	—	—	—	
—	—	—	—	—	—	—	41·1	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	41·6	—	72·8	—	—	—	—	—	—	
44·5	38·2	36·8	—	55·1	50·0	—	42·1	16·5	72·6	73·7?	98·6?	−1·1?	74·7	55·7?	—	
—	32·2	33·0?	38·9	54·2?	50·4?	56·9?	45·1?	—	71·2	74·0	96·2	−2·8	74·5?	—	—	82
—	32·0?	31·1?	—	—	—	—	42·5	—	77·1	—	—	—	—	60·3	87·2	
43·3?	36·2?	34·2?	—	—	—	—	—	—	73·4	75·5?	97·2?	−2·1?	75·0?	56·8	—	74
42·0	35·6	34·9	39·4	50·0	45·8	53·8	36·8	11·2	73·3?	69·0	106·2?	+4·3?	—	58·5	—	
44·5	34·2	34·9	42·0	—	—	—	—	—	—	—	—	—	—	—	—	74
40·8	32·1?	31·2?	38·2?	—	—	—	38·4	—	—	—	—	—	—	—	—	76

ENTS OF FEMALE ANGLO-SAXON SKULLS IN LONDON MUSEUMS.

40·6	30·6	31·2?	40·9	50·6	46·8	52·1	—	—	82·7?	76·9	107·5?	+5·8?	77·1	62·7?	73·3	65
—	—	—	—	—	—	—	42·4?	—	72·5	—	—	—	—	56·8	—	84
—	—	—	—	—	—	—	—	—	75·0?	—	—	—	—	58·2?	—	
37·0?	28·7?	29·2?	—	48·7	44·3	53·3	38·8	9·2	—	—	—	—	—	61·2	—	
—	—	—	—	—	—	—	—	—	74·8?	—	—	—	—	—	—	68
40·8	31·9	32·7	37·1?	51·2	48·7	54·2	39·2	7·8	73·0	69·4	105·3	+3·5	—	—	—	
39·1	30·1	30·1	37·1?	—	—	—	39·9	12·0?	76·8	73·1	105·0	+3·5	73·9	58·4	89·8	66
39·9	32·3	33·1	38·7	45·7	42·3	49·3	39·1	5·4	80·2	—	—	—	—	59·2	—	77
41·4	31·2	30·2	39·1?	—	—	—	42·1	—	71·2	67·5?	105·4?	+3·6?	68·0	59·2	83·5	81
38·5	32·6	29·6?	36·6?	45·4	42·7	47·0	35·3	9·8	74·1	71·5	103·6	+2·6	72·3	55·7	101·1	73
41·3?	33·1?	35·0?	39·6?	—	—	—	—	—	71·1?	—	—	—	—	—	—	66
42·8	34·9	33·8	40·1	—	—	—	42·1	11·3	72·7	71·8	101·2	+0·9	72·7	62·2?	72·0	72
42·5?	34·3?	30·1?	—	53·8	50·0	56·3	37·9	13·8	—	—	—	—	—	—	—	
42·5	34·1	37·0?	40·2	55·2	51·8	58·2?	41·2	9·6	71·0?	—	—	—	—	64·2	—	
42·2	33·5	34·0	39·8	—	—	—	—	—	75·7	—	—	—	—	59·9	—	76
40·1	30·4	30·0	39·0	51·1	47·2	55·5	37·7	7·4	73·0	—	—	—	—	—	—	72
39·0	—	—	—	—	—	—	—	—	74·5	—	—	—	—	56·8?	76·3	68
42·3?	—	30·3	39·1	—	—	—	39·8	12·7	80·7	—	—	—	—	60·7?	—	83
—	—	—	—	—	—	—	—	—	—	—	—	—	—	56·2?	71·1	
—	—	—	—	—	—	—	—	—	76·1?	—	—	—	—	—	—	
40·8	33·8	33·9	38·7	—	—	—	39·6	—	74·4?	—	—	—	—	—	—	
40·6	33·7?	33·1	38·5?	50·1	44·5	52·1	39·3	9·7	75·7	72·4	104·5	+3·1	72·1	58·4	68·8	71
—	33·8?	33·1?	—	—	—	—	45·8	—	71·1?	—	—	—	—	61·0?	—	77
43·9	35·5	34·5	40·0?	—	—	—	—	—	77·9?	—	—	—	—	66·6?	—	60
41·8	30·1?	33·9?	39·3	—	—	—	—	—	73·5	—	—	—	—	55·2?	—	79
43·0	37·5	36·7	39·7	56·2	52·9	—	39·0?	8·5?	—	—	—	—	—	58·8?	—	68
42·0	34·2	33·9?	39·3	49·8	44·4	—	38·5	10·2	71·8	73·0	99·6	−0·3	71·8	58·9	86·2	74
—	—	—	—	—	—	—	—	—	75·9?	73·7?	103·0?	+2·2?	73·1?	—	—	67
43·0	37·1	36·9	—	—	—	—	40·0	—	66·5?	—	—	—	—	—	—	
—	—	35·3	—	—	—	—	41·7	—	74·8?	—	—	—	—	—	—	
—	32·7	—	—	—	—	—	—	—	76·2?	73·5?	103·8?	+2·8?	74·0?	56·7?	83·1	76
41·0	35·3	32·9?	38·2	55·2	47·7	—	38·9	10·0	73·6	70·4?	104·5?	+3·2?	—	—	—	62
40·7	32·4	33·4	40·5	52·2	48·2	54·8	41·1	16·3	73·7	70·0	105·2	+3·7	70·0	60·7?	89·1	78
42·3	29·2	30·7	37·9?	—	—	—	—	—	75·1	—	—	—	—	58·0	—	66
—	33·7	—	37·1?	—	—	—	—	—	76·2	73·1?	104·3?	+3·1?	74·1?	60·0	82·1	

Indices

	$100\frac{fmb}{fml}$	$100\frac{G'H}{GB}$	$100\frac{NB}{NH}R$	$100\frac{NB}{NH}L$	$100\frac{NB}{NH'}$	$100\frac{DS}{DC}$	$100\frac{SS}{SC}$	$100\frac{O_2}{O_1}R$	$100\frac{O_2}{O_1}L$	$100\frac{O_2}{O_1'}$	$100\frac{EH}{EB}$	$100\frac{G_2}{G_1}$	$100\frac{G_2}{G_1'}$	$P\angle$
	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	84·3	74·7	48·6	47·7	49·7	—	—	78·1?	78·1	83·2	30·4	81·3	90·1	88°·7
	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	46·5	—	—	—	—	—	—	—
	—	—	40·5?	40·8?	41·9?	58·0?	46·5?	—	—	—	32·8	78·7	88·3	82°·5
	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	31·5	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	72·9	—	52·2	52·8	51·7	51·5	26·0	69·3	—	74·1	16·5	81·7	88·7	90°·3?
	78·9	79·9?	52·0	52·9	50·2?	—	—	74·6	76·1	80·4	29·5?	77·2?	83·0?	85°·6
	76·3	70·5	49·2	49·3	49·6	47·1	44·0	84·6	85·7	94·0	31·3	87·9	93·0	84°·2
	81·3	83·1	45·7	45·9	47·9	51·6	42·2	84·0	83·2?	86·2	34·8	79·6	87·2	90°·1
	81·8	70·3	48·1	49·1	48·4	52·8	32·7	73·5	75·2	80·0	33·0	92·4	100·7	87°·1
	—	70·1	—	41·5	41·8	76·5?	54·4	74·0	80·7	80·6	—	—	—	89°·3
	83·2	—	—	—	—	—	—	—	—	—	25·3?	85·3?	94·3?	—
	91·3?	—	—	—	—	—	—	77·9?	—	—	31·7	85·1	94·7	89°·6?
	79·0	81·8	45·6	45·7	44·6	59·8	63·0	76·7	76·9	80·9	32·9	76·7	84·6	89°·3
	84·8	—	—	—	—	—	55·8	—	—	—	—	—	—	—
	90·9	—	49·4	49·5	50·4	52·8	41·1	80·3	78·4	83·4	31·8	82·1	86·6	—
	88·8	81·5	47·1	47·8	46·4	52·4	52·3	74·3	75·2	—	—	88·8?	91·6?	91°·9
	—	—	—	—	—	70·7	59·7	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	72·8?	74·8?	—
	72·3	—	47·5	48·0	45·3	58·5	50·9	79·9	84·2	84·6	—	—	—	—
	82·8	65·4?	48·1?	48·7?	46·7?	—	48·3?	73·9	—	—	—	—	—	89°·7?
	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	75·2	73·7	51·0	51·0	49·4	—	—	80·4	76·7?	85·3	29·3	88·0	100·5	90°·8
	—	72·8?	49·6?	50·7?	46·9?	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	25·6	76·7	83·0	—
	—	—	—	—	—	—	29·6	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	82·2?	—	—	—	—	45·4	—	82·7	—	39·3	76·4	84·2	88°·3?
	87·2	—	51·5	49·6	51·6	67·2	53·5	73·7	—	82·8	—	83·2?	89·5?	85°·3?
	—	74·2?	—	—	—	—	—	—	—	—	—	—	—	86°·9?
	—	—	44·4	43·1	44·4?	—	—	85·6?	79·0?	—	—	—	—	—
	—	74·7	48·2	48·8	48·9	56·6	42·4	84·6	83·1	90·4	30·3	73·6	80·3	—
	—	76·8	46·4	46·8	46·3	57·1	64·9	76·0	78·4	81·4	—	—	—	—
	—	—	49·7?	—	48·5?	—	—	80·1?	76·5?	84·0?	—	—	—	—

7?	73·3	65·3	49·9	49·1	49·2	53·8	34·5	71·2	76·8?	74·8	—	—	—	81°·2
8	—	84·1?	—	—	—	—	—	—	—	—	—	—	—	83°·2
2?	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	68·3?	—	—	—	—	—	—	78·9?	—	23·7	79·8	87·6	81°·4
	—	—	—	—	—	—	68·5	—	—	—	—	—	—	—
4	89·8	66·9?	56·3	55·0	55·6	51·1?	30·1	77·8	80·2	86·0?	19·9	76·6	80·5	82°·9
2	—	77·0?	51·7	52·1	50·8	—	—	74·5	77·0	81·1?	30·1?	—	—	83°·0?
2	83·5	81·9	46·7	46·5	46·0?	71·4	66·6	78·4	83·0	83·5	13·8	85·6	92·4	87°·2
7	101·1	73·7	55·7	54·4	54·1?	61·2	37·0	74·3	73·0	79·8?	—	—	—	80°·3
	—	66·7?	52·1	56·1	51·9?	—	—	86·5	76·9?	89·1?	27·8	77·8	82·7	89°·4
2?	72·0	72·8?	—	—	—	—	—	78·3?	84·7?	83·6?	—	—	—	87°·2
2	—	—	48·2?	49·4?	—	53·3	43·8	80·8	79·0	87·1	26·9	—	—	—
	—	—	—	—	—	—	—	84·5?	70·9?	—	36·4	70·4	75·8	83°·7?
9	—	76·3?	47·7	46·9	46·6?	—	—	79·7	87·1?	84·8	23·4	74·6	79·6	81°·2?
	—	72·2?	44·6	44·3	44·0	68·3	52·5	80·3	80·6	84·2	—	—	—	—
8?	76·3	68·0	49·7	50·2	46·9	71·1	47·4	74·0	74·8	77·9	19·6	73·8	79·8	82°·9
7?	—	83·9?	—	—	—	—	52·3	—	—	—	—	—	—	89°·6
2?	71·1	—	53·7	54·2	54·4	64·9	47·6	—	71·7?	—	31·9	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	68·8	71·4	58·0	57·9	58·0?	46·8	36·1	79·7	83·1	87·3	—	—	—	83°·7
0?	—	77·2?	43·9	45·6	44·2?	62·4?	58·7	81·8?	81·5	87·5?	24·7	78·4	88·3	—
5?	—	60·2?	—	—	—	—	—	81·7?	—	—	—	—	—	—
2?	—	79·5?	—	—	—	—	—	83·0	78·6	88·7?	—	—	—	84°·8
8?	—	68·2?	—	—	—	—	—	—	81·1?	86·3?	—	—	—	—
9	86·2	74·2	51·7	51·9	52·4	64·3?	31·6	85·2	85·3	94·5	21·8?	69·4?	73·7?	82°·3
	—	67·5?	51·6	51·2	53·6	54·7?	45·3	80·5	80·8?	87·0	26·5	77·3	86·7	80°·4?
	—	—	—	—	—	—	40·0	—	—	—	—	—	—	—
	—	—	50·1	50·1	49·6	50·9	44·9	—	85·8	—	—	—	—	—
	—	76·1?	—	—	—	—	—	—	—	—	—	—	—	—
7?	83·1	—	—	—	—	—	—	77·9	—	—	—	—	—	—
	—	62·9	56·0?	55·2?	56·8?	38·3?	38·5	85·9	80·3?	92·4	25·7	70·5	81·6	—
7?	89·1	78·0	45·8	45·5	47·8	59·0	—	77·3	82·1	80·0	39·7	78·7	85·3	85°·2
0	—	66·2	56·8	56·3	55·2	44·0?	27·9	70·7	72·6	77·1?	—	—	—	83°·7
0	82·1	—	—	—	—	—	—	86·9	90·8?	—	—	—	—	85°·3?

Indices

$100\,\frac{G'H}{GB}$	$100\,\frac{NB}{NH}R$	$100\,\frac{NB}{NH}L$	$100\,\frac{NB}{NH'}$	$100\,\frac{DS}{DC}$	$100\,\frac{SS}{SC}$	$100\,\frac{O_2}{O_1}R$	$100\,\frac{O_2}{O_1}L$	$100\,\frac{O_2}{O_1'}$	$100\,\frac{EH}{EB}$	$100\,\frac{G_2}{G_1}$	$100\,\frac{G_2}{G_1'}$	$P\angle$	$N\angle$
—	—	—	—	—	—	—	—	—	—	—	—	—	—
74·7	48·6	47·7	49·7	—	—	78·1?	78·1	83·2	30·4	81·3	90·1	88°·7	61°·3
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	46·5	—	—	—	—	—	—	—	—
—	40·5?	40·8?	41·9?	58·0?	46·5?	—	—	—	32·8	78·7	88·3	82°·5	62°·5?
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	31·5	—	—	—	—
—	52·2	52·8	51·7	51·5	26·0	69·3	—	74·1	—	—	—	—	—
79·9?	52·0	52·9	50·2?	—	—	74·6	76·1	80·4	16·5	81·7	88·7	90°·3?	60°·2?
70·5	49·2	49·3	49·6	47·1	44·0	84·6	85·7	94·0	29·5?	77·2?	83·0?	85°·6	61°·2?
83·1	45·7	45·9	47·9	51·6	42·2	84·0	83·2?	86·2	31·3	87·9	93·0	84°·2	62°·4
70·3	48·1	49·1	48·4	52·8	32·7	73·5	75·2	80·0	34·8	79·6	87·2	90°·1	58°·9
70·1	—	41·5	41·8	76·5?	54·4	74·0	80·7	80·6	33·0	92·4	100·7	87°·1	61°·4
—	—	—	—	—	—	—	—	—	—	—	—	89°·3	—
—	—	—	—	—	—	77·9?	—	—	25·3?	85·3?	94·3?	—	—
81·8	45·6	45·7	44·6	59·8	63·0	76·7	76·9	80·9	31·7	85·1	94·7	89°·6?	60°·3?
—	—	—	—	—	55·8	—	—	—	32·9	76·7	84·6	89°·3	64°·3
—	49·4	49·5	50·4	52·8	41·1	80·3	78·4	83·4	—	—	—	—	—
81·5	47·1	47·8	46·4	52·4	52·3	74·3	75·2	—	31·8	82·1	86·6	—	—
—	—	—	—	70·7	59·7	—	—	—	—	88·8?	91·6?	91°·9	59°·0
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	47·5	48·0	45·3	58·5	50·9	79·9	84·2	84·6	—	72·8?	74·8?	—	—
65·4?	48·1?	48·7?	46·7?	—	48·3?	73·9	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	89°·7?	—
73·7	51·0	51·0	49·4	—	—	80·4	76·7?	85·3	29·3	88·0	100·5	90°·8	60°·1
72·8?	49·6?	50·7?	46·9?	—	—	—	—	—	—	—	—	—	60°·8?
—	—	—	—	—	—	—	—	—	25·6	76·7	83·0	—	—
—	—	—	—	—	29·6	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—
82·2?	—	—	—	—	—	—	—	—	—	—	—	—	—
—	51·5	49·6	51·6	67·2	45·4	—	82·7	—	39·3	76·4	84·2	88°·3?	59°·8?
74·2?	—	—	—	—	53·5	73·7	—	82·8	—	83·2?	89·5?	85°·3?	67°·5?
—	44·4	43·1	44·4?	—	—	—	79·0?	—	—	—	—	86°·9?	—
74·7	48·2	48·8	48·9	56·6	42·4	85·6?	83·1	90·4	30·3	73·6	80·3	—	66°·7
76·8	46·4	46·8	46·3	57·1	64·9	84·6	78·4	81·4	—	—	—	—	—
—	49·7?	—	48·5?	—	—	76·0	76·5?	84·0?	—	—	—	—	—
						80·1?							

65·3	49·9	49·1	49·2	53·8	34·5	71·2	76·8?	74·8	—	—	—	81°·2	68°·6
84·1?	—	—	—	—	—	—	—	—	—	—	—	83°·2	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—
68·3?	—	—	—	—	—	—	78·9?	—	23·7	79·8	87·6	81°·4	—
—	—	—	—	—	68·5	—	—	—	—	—	—	—	64°·4
66·9?	56·3	55·0	55·6	51·1?	30·1	77·8	80·2	86·0?	19·9	76·6	80·5	82°·9	66°·0
77·0?	51·7	52·1	50·8	—	—	74·5	77·0	81·1?	30·1?	—	—	83°·0?	—
81·9	46·7	46·5	46·0?	71·4	66·6	78·4	83·0	83·5	13·8	85·6	92·4	87°·2	—
73·7	55·7	54·4	54·1?	61·2	37·0	74·3	73·0	79·8?	—	—	—	80°·3	70°·5
66·7?	52·1	56·1	51·9?	—	—	86·5	76·9?	89·1?	27·8	77·8	82·7	89°·4	—
72·8?	—	—	—	—	—	78·3?	84·7?	83·6?	—	—	—	87°·2	63°·2?
—	48·2?	49·4?	—	53·3	43·8	80·8	79·0	87·1	26·9	—	—	—	—
—	—	—	—	—	—	84·5?	70·9?	—	36·4	70·4	75·8	83°·7?	—
76·3?	47·7	46·9	46·6?	—	—	79·7	87·1?	84·8	23·4	74·6	79·6	81°·2?	—
72·2?	44·6	44·3	44·0	68·3	52·5	80·3	80·6	84·2	—	—	—	—	—
68·0	49·7	50·2	46·9	71·1	47·4	74·0	74·8	77·9	19·6	73·8	79·8	82°·9	70°·6
83·9?	—	—	—	—	52·3	—	—	—	—	—	—	89°·6	—
—	53·7	54·2	54·4	64·9	47·6	—	71·7?	—	31·9	—	—	—	70°·1?
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—
71·4	58·0	57·9	58·0?	46·8	36·1	79·7	83·1	87·3	—	—	—	—	—
77·2?	43·9	45·6	44·2?	62·4?	58·7	81·8?	81·5	87·5?	24·7	78·4	88·3	83°·7	65°·3
60·2?	—	—	—	—	—	81·7?	—	—	—	—	—	—	—
79·5?	—	—	—	—	—	83·0	78·6	88·7?	—	—	—	—	—
68·2?	—	—	—	—	—	—	81·1?	86·3?	—	—	—	84°·8	—
74·2	51·7	51·9	52·4	64·3?	31·6	85·2	85·3	94·5	21·8?	69·4?	73·7?	—	—
67·5?	51·6	51·2	53·6	54·7?	45·3	80·5	80·8?	87·0	26·5	77·3	86·7	82°·3	66°·1
—	—	—	—	—	40·0	—	—	—	—	—	—	80°·4?	71°·9?
—	50·1	50·1	49·6	50·9	44·9	—	85·8	—	—	—	—	—	—
76·1?	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	77·9	—	—	—	—	—	—	—
62·9	56·0?	55·2?	56·8?	38·3?	38·5	85·9	80·3?	92·4	25·7	70·5	81·6	—	73°·4?
78·0	45·8	45·5	47·8	59·0	—	77·3	82·1	80·0	39·7	78·7	85·3	85°·2	65°·0
66·2	56·8	56·3	55·2	44·0?	27·9	70·7	72·6	77·1?	—	—	—	83°·7	—
—	—	—	—	—	—	86·9	90·8?	—	—	—	—	85°·3?	63°·8?

Angles

$P\angle$	$N\angle$	$A\angle$	$B\angle$	θ_1	θ_2	Remarks
—	—	—	—	—	—	Aging.
88°·7	61°·3	77°·1	41°·6	30°·0	11°·6	Trepanned frontal bone?
—	—	—	—	—	—	
—	—	—	—	—	—	
82°·5	62°·5?	76°·2?	41°·3?	35°·0?	6°·3?	Aging.
—	—	—	—	—	—	
—	—	—	—	—	—	
—	—	—	—	—	—	
90°·3?	60°·2?	75°·9?	43°·9?	29°·5?	14°·4?	
85°·6	61°·2?	76°·4?	42°·4?	33°·2?	9°·2?	
84°·2	62°·4	77°·9	39°·7	33°·4	6°·3	
90°·1	58°·9	75°·8	45°·3	31°·0	14°·3	
87°·1	61°·4	78°·2	40°·4	31°·5	8°·9	
89°·3	—	—	—	—	—	Temporo-frontal articulation R. and L.
—	—	—	—	—	—	Young adult.
89°·6?	60°·3?	79°·6?	40°·1?	30°·1?	10°·0?	
89°·3	64°·3	72°·9	42°·8	26°·4	16°·4	
—	—	—	—	—	—	
—	—	—	—	—	—	Metopic suture nearly closed; epipteric bones R. and L.
91°·9	59°·0	74°·9	46°·1	29°·1	17°·0	Epipteric bones R. and L.; hole (80 × 55 mm.) with nearly healed edge in parietal R.
—	—	—	—	—	—	Transfixed by spear-head.
—	—	—	—	—	—	
—	—	—	—	—	—	Aged; ossicle of β (30 × 10 mm.).
89°·7?	—	—	—	—	—	Supernumerary upper premolar L. and incisors irregularly placed: bipartite interparietal.
—	—	—	—	—	—	
90°·8	60°·1	75°·0	44°·9	29°·1	15°·8	Metopic; divided jugular foramen L.
—	60°·8?	79°·3?	39°·9?	—	—	Small wormians lambdoid suture R. and L.
—	—	—	—	—	—	Aging; sutures closed and vault falling in.
—	—	—	—	—	—	Depression of obelion.
—	—	—	—	—	—	
—	—	—	—	—	—	Flattened obelion.
88°·3?	59°·8?	77°·1?	43°·1?	31°·9?	11°·2?	Aging.
85°·3?	67°·5?	72°·5?	40°·0?	27°·2?	12°·8?	
86°·9?	—	—	—	—	—	
—	—	—	—	—	—	
—	66°·7	72°·0	41°·3	—	—	Aging.
—	—	—	—	—	—	
—	—	—	—	—	—	

81°·2	68°·6	75°·9	35°·5	30°·2	5°·3	Aging.
83°·2	—	—	—	—	—	Single wormians in lambdoid suture R. and L.
—	—	—	—	—	—	
—	—	—	—	—	—	
81°·4	—	—	—	—	—	
—	64°·4	74°·0	41°·2	28°·4	12°·8	Aging.
82°·9	66°·0	74°·0	40°·0	31°·1	8°·9	Metopic; 4 ossicles round lambda.
83°·0?	—	—	—	—	—	
87°·2	—	—	—	—	—	Aging.
80°·3	70°·5	70°·5	39°·0	29°·2	9°·8	Aging.
89°·4	—	—	—	—	—	Young adult; small epipteric bone R.
87°·2	63°·2?	77°·4?	39°·4?	29°·6?	9°·8?	Aging.
—	—	—	—	—	—	
83°·7?	—	—	—	—	—	Metopic.
81°·2?	—	—	—	—	—	Wormians lambdoid suture R. and L.; palatine torus.
—	—	—	—	—	—	Old; vault falling in; copper stains on facial bones and mandible.
82°·9	70°·6	70°·9	38°·5	26°·5	12°·0	Young adult, bathrocephalic.
89°·6	—	—	—	—	—	No 3rd molars.
—	70°·1?	70°·6?	39°·3?	—	—	
—	—	—	—	—	—	Aging.
—	—	—	—	—	—	Aging.
83°·7	65°·3	73°·4	41°·3	23°·9	10°·3	Young adult, metopic.
—	—	—	—	—	—	Aging.
—	—	—	—	—	—	
84°·8	—	—	—	—	—	Old, large ossicle of lambda.
—	—	—	—	—	—	
82°·3	66°·1	71°·9	42°·0	31°·6	10°·4	Aging; epipteric bones R. and L.
80°·4?	71°·9?	69°·7?	38°·4?	27°·7?	10°·7?	Young adult.
—	—	—	—	—	—	
—	—	—	—	—	—	
—	—	—	—	—	—	
—	—	—	—	—	—	Copper stained mandible.
—	73°·4?	70°·0?	36°·6?	—	—	Young adult, copper stained mandible.
85°·2	65°·0	74°·4	40°·6	29°·8	10°·8	Aging.
83°·7	—	—	—	—	—	Ossicle of lambda and ossicles lambdoid suture R. and L.
85°·3?	63°·8?	74°·2?	42°·0?	30°·9?	11°·1?	

Museum	Graveyard and Reference	Mus. No.	Div.	Sex	Lengths F	L	B	B′	H′
B.M.	Sleaford, Lincs. *Arch.* L. 1887	1	A.	♂	198	201	141?	97·6	—
,,	,, ,,	4	,,	♂	—	—	135?	—	—
,,	,, ,,	6	,,	♂	192?	198·5?	133·5?	94·0	—
,,	,, ,,	7	,,	♂?	186	188	143?	—	—
,,	,, ,,	8	,,	♂?	197	196	—	—	—
,,	,, ,,	9	,,	♂	201?	205?	142?	95·8	—
,,	,, ,,	12	,,	♂	193?	—	140?	—	—
,,	,, ,,	15	,,	♂?	193?	195?	—	—	—
,,	,, ,,	16	,,	♂?	—	—	137	93·7	—
,,	,, ,,	2	,,	♂?	—	—	—	—	—
R.C.S.	Linton Heath, Cambs.	B.D. 43	,,	♂	183?	183?	142?	92·7	—
,,	Sedgeford Hall, Norfolk	317·22	,,	♂	182	183·5	133	—	—
,,	Islip, Northants.	319·1	,,	♂	198·5?	202·5?	143?	94·8	—
,,	Strood, Kent. *Coll. Antiq.* v. p. 129	B.D. 673	J.	♂	—	—	138?	—	—
,,	Isle of Thanet	B.D. 1310	,,	♂?	187	190	138·5?	95·9	—
,,	Broadstairs. *J.R.A.I.* XLIII. 1913, p. 550	366·13	,,	♂	187?	185?	—	—	—
,,	Folkestone. *J.R.A.I.* XLI. 1911, p. 101	1	,,	♂	—	—	—	95·0?	—
,,	,, ,, ,,	2	,,	♂	—	—	—	94·1	—
,,	,, ,, ,,	332·22 3	,,	♂	—	—	—	100·8	—
,,	,, ,, ,,	10	,,	♂	194	—	147?	—	—
,,	,, ,, ,,	?	,,	♂	—	—	—	—	—
,,	Droxford, Hants.	350·5	,,	♂	—	—	—	—	—
,,	Newbury. *J.R.A.I.* XLV. 1915, p. 92	350·24	W.S.	♂	190?	190?	133?	97·6	—
,,	Bishopstone, Bucks.	324	,,	♂?	194	196·5	146·5	95·9	—
,,	Mitcham, Surrey	104	S.S.	♂?	184?	188?	—	96·0	—
,,	Kemp Town, Brighton	B.D. 54	,,	♂	195	198	150	100·2	136
,,	Mitcham, Surrey	346·72	,,	♂?	188	191	—	99·8	—
,,	,,	346·73	,,	♂?	—	—	—	102·1	—
,,	,,	346·74	,,	♂?	—	—	148?	—	—

Museum	Graveyard and Reference	Mus. No.	Div.	Sex	Lengths F	L	B	B′	H′
B.M.	Sleaford, Lincs. *Arch.* L. 1887	19	A.	♀	184?	185?	129·5?	92·7	129?
,,	,, ,,	23	,,	♀?	—	—	—	89·0	—
,,	,, ,,	24	,,	♀	—	—	—	86·0	—
,,	,, ,,	26	,,	♀	—	—	—	—	—
,,	,, ,,	27	,,	♀	193·5?	195?	—	—	—
,,	,, ,,	29	,,	♀	183·5	185·5	127·5	94·6	—
,,	,, ,,	30	,,	♀?	—	—	143?	—	—
R.C.S.	Islip, Northants.	319·2	,,	♀?	174·5?	174?	135·5?	98·2	119?
,,	? *Locus*	B.D. 74	J.	♀	176·5	176	122?	—	120?
,,	Broadstairs. *J.R.A.I.* XLIII. 1913, p. 550	366·16	,,	♀	—	—	—	94·1	—
,,	Folkestone. *J.R.A.I.* XLI. 1911, p. 101	4	,,	♀	—	—	—	91·5	—
,,	,, ,, ,,	5	,,	♀	—	—	—	90·2	—
,,	,, ,, ,,	332·22 6	,,	♀	—	—	—	—	—
,,	,, ,, ,,	7	,,	♀	—	—	—	91·9	—
,,	,, ,, ,,	11	,,	♀	180	181·5	—	—	—
,,	Newbury. *J.R.A.I.* XLV. 1915, p. 92	350·37	W.S.	♀	—	—	—	96·3?	—
,,	,, ,, ,,	350·39	,,	♀	—	—	—	97·9	—
,,	,, ,, ,,	350·40	,,	♀	190·5?	195·5?	134·5?	87·9?	—
,,	,, ,, ,,	350·45	,,	♀	174·5?	179?	141·5?	—	—
,,	West Harnham, Wilts.	B.D. 125	,,	♀	180	181	131	93·7	136·5
,,	,, ,,	B.D. 126	,,	♀	187·5	186·5	144	93·9	136
,,	Lewes	B.D. 925	S.S.	♀	181	181·5	135	92·0	135
,,	Mitcham, Surrey	111	,,	♀	—	—	—	—	130
,,	,,	116	,,	♀	182	182	133	—	131

INDIVIDUAL MEASUREMENTS OF MALE ANGLO-SAXON SKUL

	Lengths				Arcs						Foramen		Indice			
	B	*B′*	*H′*	*LB*	*S*	S_1	S_2	S_3	S_2'	*U*	*fml*	*fmb*	$100\frac{B}{L}$	$100\frac{H'}{L}$	$100\frac{B}{H'}$	10
	141?	97·6	—	—	—	134·5	151	—	—	—	—	—	70·2?	—	—	
	135?	—	—	—	—	—	140	109·5	92·0	—	—	—	—	—	—	
5?	133·5?	94·0	—	—	377	132	124	121	94·5	—	—	—	67·2?	—	—	
	143?	—	—	—	—	130	130	—	—	—	—	—	76·1?	—	—	
	—	—	—	—	—	—	129	119·5	—	—	—	—	—	—	—	
	142?	95·8	—	—	—	136	139	—	—	—	—	—	69·2?	—	—	
	140?	—	—	—	—	—	138	120·5	99·0	—	—	—	—	—	—	
	—	—	—	—	—	126?	135	—	—	—	—	—	—	—	—	
	137	93·7	—	—	—	124	130	—	—	—	—	—	—	—	—	
	—	—	—	—	—	—	124	—	—	—	—	—	—	—	—	
	142?	92·7	—	—	388?	136	135?	117?	99·7?	—	—	—	—	—	—	
5	133	—	—	—	—	129	128	—	—	—	—	—	77·6?	—	—	
5?	143?	94·8	—	—	—	—	—	—	—	—	—	—	72·5	—	—	
	138?	—	—	—	—	—	128?	123?	97·0	—	—	—	70·6?	—	—	
	138·5?	95·9	—	—	386·5	135?	133·5?	118?	101·0	—	—	—	—	—	—	
	—	—	—	—	—	—	—	—	—	—	—	—	72·9?	—	—	
	—	95·0?	—	—	—	—	—	—	—	—	—	—	—	—	—	
	—	94·1	—	—	—	—	—	—	—	—	—	—	—	—	—	
	—	100·8	—	—	—	—	—	—	—	—	—	—	—	—	—	
	147?	—	—	—	—	134	129?	—	—	—	—	—	—	—	—	
	—	—	—	—	—	—	120?	—	—	—	—	—	—	—	—	
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	—	—	—	—	—	—	121·5	—	—	—	—	34·3	—	—	—	
?	133?	97·6	—	—	—	129·5?	127·0?	—	—	—	—	—	—	—	—	
5	146·5	95·9	—	—	392·5	137	135	120·5	94·0	544?	—	—	70·0?	—	—	
?	—	96·0	—	—	—	120·5	118·5?	—	—	—	—	—	74·5	—	—	
	150	100·2	136	106·1	394·5	135·5	125	134	107·1	551	34·0	29·5	75·8	68·7	110·3	
	—	99·8	—	—	380	122	143·5?	114·5?	99·0?	—	—	—	—	—	—	
	—	102·1	—	—	—	133·5	—	—	—	—	—	—	—	—	—	
	148?	—	—	—	—	126?	128?	—	—	—	—	—	—	—	—	

INDIVIDUAL MEASUREMENTS OF FEMALE ANGLO-SAXON SKUL

?	129·5?	92·7	129?	—	—	—	135	113	—	505	—	—	70·0?	69·7?	100·4?	
	—	89·0	—	—	—	122	—	114·5?	93·8?	—	37·0	29·3	—	—	—	
	—	86·0	—	—	—	119?	—	112	97·0	—	—	—	—	—	—	
	—	—	—	—	—	—	—	101·5?	86·8?	—	—	—	—	—	—	
?	—	—	—	—	—	120	131	—	—	—	—	—	—	—	—	
5	127·5	94·6	—	—	—	135	117	—	—	509?	—	—	68·7	—	—	
?	135·5?	98·2	119?	99·2?	—	116?	119?	—	—	—	—	—	—	—	—	
	122?	—	120?	—	—	118·5	116·5	—	—	495?	—	—	77·9?	68·4?	113·9?	
	—	94·1	—	—	—	137·5?	—	—	—	—	—	30·2	69·3?	68·3?	101·5?	
	—	91·5	—	—	—	124·5	—	—	—	—	—	—	—	—	—	
	—	90·2	—	—	—	116·5	—	—	—	—	—	—	—	—	—	
	—	—	—	—	—	—	97?	—	—	—	—	—	—	—	—	
	—	91·9	—	—	—	—	—	—	—	—	—	—	—	—	—	
5	—	—	—	—	360·5	126	121	113·5	97·1	—	—	—	—	—	—	
	—	96·3?	—	—	—	121·5?	—	—	93·9?	—	—	—	—	—	—	
	—	97·9	—	—	—	126?	—	—	—	—	—	—	—	—	—	
5?	134·5?	87·9?	—	—	—	127?	137?	—	—	—	—	—	—	—	—	
?	141·5?	—	—	—	—	133?	125?	—	—	—	—	—	68·8?	—	—	
	131	93·7	136·5	97·8	377	131	129	117	98·0	502·5	32·6	27·0	79·0?	—	—	
5	144	93·9	136	99·9	375	131	121	123	98·0	522·5?	37·5	—	72·4	75·4	96·0	
5	135	92·0	135	101·6	362	123	125	114	98·2	507?	38·8	31·1	77·3	73·0	105·9	
	—	—	130	—	—	—	113·5	114	96·0	—	35·0	33·4	74·4	74·4	100·0	
	133	—	131	—	363	121	121	121	97·3	—	35·2	27·1	—	—	—	
													73·1	72·0	101·5	

ON SKULLS IN LONDON MUSEUMS. *Calvariae without Facial Bones.*

	Indices				
$\frac{'}{L}$	$100\frac{B}{H'}$	$100\frac{(B-H')}{L}$	$100\frac{fmb}{fml}$	*Oc.I.*	REMARKS
	—	—	—	—	
	—	—	—	60·8	Aging.
	—	—	—	55·9	(*Q'* passing 25 mm. behind bregma = 326?.)
	—	—	—	—	*Q'* = 320?.
	—	—	—	—	Young adult.
	—	—	—	—	Aging.
	—	—	—	58·8	Trepanned R. parietal. Opening 50 × 20 mm. with healed edge. *Q'* = 326?.
	—	—	—	—	
	—	—	—	—	
	—	—	—	—	Healed sword-cut.
	—	—	—	62·2?	
	—	—	—	—	
	—	—	—	—	
	—	—	—	56·3?	Aging.
	—	—	—	62·9?	Aging.
	—	—	—	—	
	—	—	—	—	
	—	—	—	—	
	—	—	—	—	
	—	—	—	—	
	—	—	—	—	
	—	—	—	—	Metopic.
	—	—	—	—	Aging.
	—	—	—	55·8	
	—	—	—	—	Aging.
7	110·3	+7·1	86·8	57·0	Large ossicle L. lambdoid.
	—	—	—	64·1?	Aging.
	—	—	—	—	Metopic suture nearly closed.
	—	—	—	—	Metopic: healed wound or trepanned opening in frontal and parietal L. 30 × 20 mm.

KON SKULLS IN LONDON MUSEUMS. *Calvariae without Facial Bones.*

7?	100·4?	+0·3?	—	—	
	—	—	79·2	58·6?	
	—	—	—	64·5	Young adult?.
	—	—	—	62·7?	
	—	—	—	—	Young adult.
	—	—	—	—	*L'* = 183·0?.
	—	—	—	—	
4?	113·9?	+9·5?	—	—	Young adult, metopic.
3?	101·5?	+1·0?	—	—	Aging.
	—	—	—	—	
	—	—	—	—	
	—	—	—	—	
	—	—	—	—	
	—	—	—	—	
	—	—	—	62·8	Aging.
	—	—	—	—	
	—	—	—	—	
	—	—	—	—	
	—	—	—	—	
4	96·0	−3·1	82·8	60·5	
0	105·9	+4·3	—	56·8	*SC* = 9·4, *SS* = 5·6, epipteric bone L.
4	100·0	0·0	80·0	63·6	Young adult, metopic.
—	—	—	95·5	61·0	Wormians lambdoid R. and L.; 2 small ossicles in sagittal near lambda.
0	101·5	+1·0	77·0	57·3	*PH* = 19·2.

THE PRESENT STATE OF OUR KNOWLEDGE OF BRITISH CRANIOLOGY IN LATE PREHISTORIC AND HISTORIC TIMES.

By BEATRIX G. E. HOOKE and GEOFFREY M. MORANT, M.Sc.

Two contributions to the study of British craniology are provided in this number of *Biometrika*: that giving individual measurements of 350 skulls of the 17th century Londoners compared with other modern material furnished by one of the present writers, and the measurements of Anglo-Saxon skulls in London museums compared with other series of earlier date furnished by the other. Both are biometric studies continuing the survey of British material which was inaugurated by the two classical papers of Macdonell. Free use has been made of the method of the Coefficient of Racial Likeness which has proved an additional aid of extreme value since those pioneer studies were made. It can hardly be necessary to acknowledge in the pages of *Biometrika* the fact that as regards descriptive technique and methods of analysis we have been guided entirely by the procedure which owes its inception to Professor Karl Pearson, but we would wish to record our more direct indebtedness to him for inspiring and aiding us in this work.

Our present purpose is to compare the earlier and later groups of cranial series with one another and thus to provide a *résumé* of the present state of our knowledge of British ethnology as revealed by cranial remains, and, perhaps we ought to add, as envisaged by those who approach such questions from the biometric standpoint. We are probably far more conscious of the incompleteness of the existing evidence than the critics of such methods will be. Of all the available series there is only one—the Farringdon Street—which fulfils the two main requirements of the craniometrician in that it is large enough to furnish reliable statistical criteria and that it has been adequately described by direct measurements and type contours. Macdonell's Whitechapel series nearly fulfils both requirements, but all the other series dealt with are defective in one way or the other or in both. We present the following tentative conclusions, then, with a full consciousness of the limitations of the material and the hope that they will shortly be confirmed or modified by more adequate studies.

The Coefficients of Racial Likeness (C.R.L.'s) between the ♂ and ♀ series of 17th century London skulls measured in the Biometric Laboratory and the Anglo-Saxon and earlier types for which mean measurements could be found are given in Table I. From a comparison of them and of the C.R.L.'s previously given we conclude that:

(*a*) In late Neolithic times, and probably in early Neolithic times also, the population of England and Scotland was racially homogeneous and of a type

TABLE I. *Coefficients of Racial Likeness of 17th Century London and Earlier British Series.*

		British Neolithic	English Bronze Age	Scottish Bronze Age	British Iron Age	Anglo-Saxon
		Male				
		(38·0)*	(32·6)*	(18·7)*	(53·4)*	(41·2)*
Farringdon Street (95·6)	All Characters ...	13·60 ± ·18 (27)	15·11 ± ·18 (27)	7·50 ± ·20 (21)	2·82 ± ·20 (22)	5·27 ± ·17 (30)
	Indices and Angles...	18·84 ± ·30 (9)	19·77 ± ·30 (9)	5·67 ± ·33 (7)	4·32 ± ·36 (6)	7·82 ± ·29 (10)
Whitechapel (93·5)	All Characters ...	7·44 ± ·18 (27)	18·83 ± ·18 (28)	7·12 ± ·20 (22)	0·38 ± ·20 (23)	2·98 ± ·19 (27)
	Indices and Angles...	8·33 ± ·30 (9)	25·35 ± ·29 (10)	5·85 ± ·33 (7)	0·57 ± ·33 (7)	2·14 ± ·29 (10)
Moorfields (28·8)	All Characters ...	8·29 ± ·19 (23)	9·54 ± ·19 (24)	5·87 ± ·22 (18)	1·55 ± ·21 (19)	4·88 ± ·19 (25)
	Indices and Angles...	13·41 ± ·33 (7)	12·60 ± ·32 (8)	6·12 ± ·38 (5)	3·40 ± ·38 (5)	6·96 ± ·32 (8)
Mean Coefficient	All Characters ...	9·78	14·49	6·83	1·58	4·38
		Female			(31·9)*	(32·1)*
Farringdon Street (114·2)	All Characters ...	—	—	—	2·81 ± ·21 (19)	6·51 ± ·17 (31)
	Indices and Angles...	—	—	—	3·02 ± ·36 (6)	7·72 ± ·27 (11)
Whitechapel (91·4)	All Characters ...	—	—	—	1·84 ± ·22 (17)	9·61 ± ·20 (22)
	Indices and Angles...	—	—	—	0·55 ± ·38 (5)	7·99 ± ·32 (8)
Moorfields (38·9)	All Characters ...	—	—	—	1·32 ± ·22 (17)	4·66 ± ·19 (25)
	Indices and Angles...	—	—	—	3·22 ± ·38 (5)	6·45 ± ·32 (8)
Mean Coefficient	All Characters ...	—	—	—	1·99	6·93

* These are the mean numbers of skulls on which the Iron Age and Anglo-Saxon mean characters used in computing the female Coefficients are based.

This table indicates that the modern English skull resembles more closely the British Iron Age type than the Anglo-Saxon. In fact the three modern English series are on the average nearer to the Iron Age type than they are to each other (mean C.R.L.'s: ♂'s, 2·67; ♀'s, 4·02), although the three groups were inhabitants of the same city, living practically at the same period, only in different parishes.

which is clearly distinguished from that of the races which predominated in later times. Its salient characters are a most extreme skull length and a low cephalic index. The brain box was of a normal height.

(*b*) An invading race introduced the Bronze Age culture into Britain. The invaders arrived on the east coast, spread westwards and settled in considerable numbers over the whole island. Being brachycephalic they can be clearly distinguished from the people they conquered. There appears to have been some blood admixture between the two races, and some skulls of the pure Neolithic type are found associated with Bronze Age artifacts, but it is highly probable that the remnant of the indigenous population which was not exterminated was absorbed by the invading people without producing any sensible modification of that type. The English and Scottish Bronze Age populations with which we have acquaintance are very similar, but not sufficiently so to warrant the assumption that they belonged to identically the same racial population.

(*c*) It is surprising to find that by the Iron Age the brachycephalic Beaker people had almost entirely disappeared from England. A considerable number of skulls from widely scattered areas and ranging in age from the early Iron Age to Roman times all form, with some doubtful exceptions which are certainly not of the Bronze Age type, a homogeneous population. It is distinguished from the Neolithic type by its shorter length, greater cephalic index—it being only just dolichocephalic—and, most characteristically, by its low vault and retreating frontal bone. The few Scottish Iron Age skulls of which measurements have been given all come from the West Lowlands and they conform to identically the same type. We can only suppose that it represents an invading people which entirely displaced and probably largely exterminated the settled Bronze Age folk over the greater part of Britain. From the fact that a brachycephalic type is found in Scotland in later historic times we may infer that some of the Bronze Age people avoided extinction by seeking shelter in the more inaccessible regions of that country, but more direct evidence in support of such a theory will be needed before it can be considered established. As far as we can tell the miscegenation of the natives with alien elements introduced into England at the time of the Roman occupation had no permanent effect on the predominating Iron Age type.

(*d*) That the Anglo-Saxons came to England and the south of Scotland in large numbers is evidenced by the numerous grave-yards that have been found. But the skulls of which measurements have as yet been published are miserably few in number. They were all interred between the 5th and the end of the 9th century and no distinction can be found between the remains from the earlier and later settlements. Angles, Saxons and Jutes all belonged, as far as we can tell, to a single homogeneous racial type which is in some ways similar to that of the British Iron Age population—the two have almost identical cephalic indices—but it is clearly distinguished from that of the conquered people by its greater skull height and absence of a retreating forehead. The ♀ skulls are of

precisely the same type as the ♂, suggesting that the two peoples lived side by side without mixing until at least as late as the 10th century.

(*e*) There are no adequately described series of English skulls of mediaeval date. The cranial type of Londoners of the 17th century is now well-known by the three collections—the Whitechapel, Moorfields and Farringdon Street—measured in the Biometric Laboratory. The three are very similar but not sufficiently so to warrant the assumption that they are random samples drawn from a single homogeneous population. All show a decidedly stronger bond of affinity with the British Iron Age type than with any other of the early ones (cf. the C.R.L.'s in Table I), and the C.R.L. with the Whitechapel skulls is so low that the assumption of identity of type is almost justified. The two appear to be more closely related to one another than the Whitechapel series is to the other two London ones contemporary with it. It can be definitely stated that the divergence of the Farringdon Street and Moorfields type from that of the Whitechapel and Iron Age skulls is not towards the Anglo-Saxons but in the opposite direction (see Table I)*. The two former show the distinguishing characters of a low calvarial height and a markedly retreating forehead more accentuated than do the two latter. A population of modern skulls from the Lowlands of Scotland measured by Sir William Turner (the Lowland Type (48·2)) gives means almost indistinguishable from those of the British Iron Age (53·4): Coefficients are found of 0·94 ± ·19 for 23 characters and 0·97 ± ·33 for 7 indices and angles. The similarity to the Whitechapel English is again very close while the Moorfields and Farringdon Street series are further removed. An almost identical population seems to have been found by Young† in a modern Glasgow cemetery, but we have not used his measurements as the skulls appear to have been inaccurately sexed. Now the undoubtedly significant differences of all these variants of the same type from one another and from the Anglo-Saxon mean measurements are confined to two only of the direct measurements compared—the basio-bregmatic height H', involving the indices $100\,H'/L$ and $100\,B/H'$, and the nasio-basion length (LB). The cephalic index and its component lengths appear to be identical for all. As is shown in Table II, the differentiating characters H' and LB arrange the types in the same order, which is that given by the Coefficient of Racial Likeness.

In the case of the modern Lowland Scottish populations it is reasonable enough to suppose that the type is directly descended from the British Iron Age race and that it was modified slightly by admixture with invaders who settled in the country in the early centuries of the present era and the majority of whom were, in all probability, the founders of the kingdom of Bernicia. The 17th century Londoners had undoubtedly the same origin, but we cannot detect the slightest effect of admixture with Anglo-Saxon elements and, at present, we are unable to

* The more salient differences between the Anglo-Saxon type and that of the 17th century Londoners (Farringdon Street) can be clearly seen by superposing the contours provided (with tracings) in our earlier papers.

† Young, *Trans. Royal Soc. Edinburgh*, Vol. LI. Part II. (No. 9), 1916.

TABLE II. *Mean Male Measurements of some British Cranial Series.*

	100 *B/L*	*L*	*B*	*H'*	*LB*	100 *H'/L*	100 *B/H*
Moorfields ...	75·5 (42)	189·2 (44)	143·0 (46)	129·8 (34)	98·5 (35)	68·4 (31)	110·2 (34)
Farringdon Street	75·4 (132)	188·8 (139)	142·4 (141)	129·7 (118)	100·1 (118)	68·6 (115)	109·8 (117)
Whitechapel ...	74·3 (131)	189·1 (137)	140·7 (135)	132·0 (122)	101·6 (119)	70·0 (120)	106·6 (122)
British Iron Age...	75·4 (61)	187·4 (61)	141·4 (102)	132·9 (77)	101·6 (67)	70·9 (61)	106·3 (77)
Lowland Scottish (Turner)	75·3 (54)	188·8 (54)	142·1 (54)	133·6 (52)	102·0 (52)	70·9 (52)	106·4 (52)
Glasgow (Young)	74·4 (405)	—	—	—	—	70·8 (405)	105·2 (405)
Anglo-Saxon ...	74·7 (52)	190·6 (58)	141·7 (103)	136·0 (31)	104·1 (31)	71·2 (25)	104·9 (61)

offer any hypothesis which would explain how they acquired their distinctive characters. We are unwilling to free ourselves from this *impasse* by supposing that the modern type was evolved from the ancestral one by gradually acquiring a form which would generally be considered to indicate a more primitive type! The selection of the material from different social strata may possibly account for the seeming anomaly. More ample comparative data will no doubt provide a rational explanation.

(*f*) From data provided by Sir William Turner we have acquaintance with another type of modern Scottish skull which is markedly contrasted to the one predominating in the Lowlands. It is represented by remains found in proximity to the latter (Fifeshire and East Lothian) and in the north-east counties. As it is brachycephalic, comparison can only be made with the Bronze Age types. The following C.R.L.'s are found:

TABLE III. *Coefficients of Racial Likeness between British Brachycephalic Types.*

		English Bronze Age (32·6)	Scottish Bronze Age (21·8)	Turner's Eastern Scottish (21·1)
English Bronze Age (32·6)	All Characters ...	—	6·58 ± ·20 (22)	3·37 ± ·20 (23)
	Indices and Angles	—	12·69 ± ·33 (7)	3·09 ± ·33 (7)
Scottish Bronze Age (21·8)	All Characters ...	6·58 ± ·20 (22)	—	2·88 ± ·20 (21)
	Indices and Angles	12·69 ± ·33 (7)	—	3·70 ± ·33 (7)
Turner's Eastern Scottish (21·1)	All Characters ...	3·37 ± ·20 (23)	2·88 ± ·20 (21)	—
	Indices and Angles	3·09 ± ·33 (7)	3·70 ± ·33 (7)	—

None of the Coefficients shown in Table III indicate a close similarity—it being noticed that the mean numbers of skulls on which the means are based are small—but they are all of a lower order than the C.R.L.'s found between the three types and the other British ones and we may assume that the populations were inter-related. The modern Scottish brachycephalic skull is apparently characterised by a lower calvarial height than that of the Bronze Age people, but there is no clear evidence to suggest that it acquired that character as the result of miscegenation with a low-browed race like the Lowland Scottish. The material is too meagre to justify us in forming further conclusions.

(*g*) The only other long modern series of British crania for which measurements have been published are the two late mediaeval ones from Hythe (Kent) and Rothwell (Northants). The number of measurements given for the individual skulls is too small to be of much value, nor do the frequency distributions of the characters satisfy the conditions which the biometrician imposes as a test of racially homogeneous populations. The mean measurements of the series neither accord with one another nor with those of any other British series.

To summarise the above conclusions:—We have acquaintance with four distinct cranial types found in England and Scotland during the period extending from late Neolithic times to the present day.

(*a*) An extremely dolichocephalic Neolithic type which was probably extinct before the end of the Bronze Age.

(*b*) A brachycephalic Bronze Age type which had apparently disappeared from England and the greater part of Scotland by the time the Iron Age invaders had settled in the country, but which persisted in the remoter parts of the latter country*.

(*c*) An Iron Age type from which the modern population of the greater part of Britain is directly descended and which has not been essentially modified since its first appearance.

(*d*) The distinct type of the Anglo-Saxon invaders which persisted in a pure form for several centuries and appears to have been finally absorbed by the native population without appreciably modifying the latter.

It is noteworthy that two of these cranial types possess characters which place them on the edge of the distribution of mean characters—the inter-racial distributions—for all races of *homo sapiens*. The extreme values are the great length and low cephalic index of the Neolithic skulls and the extraordinarily low calvarial height in proportion to the calvarial length ($100\,H'/L$) shown by all the variants of the Iron Age type and especially by the Farringdon Street and Moorfields series. It may be noted, too, that the most significant differences between the types are almost entirely confined to calvarial characters. That is, perhaps, partly due to the fact that they are invariably based on larger numbers of skulls than the mean facial measurements. We would wish to emphasize again the fact that the above conclusions can lay no claim to be final. They provide what appears to us to be the most reasonable scheme of the inter-relations between the populations represented by the available scanty material, and if the reader thinks that certain of our statements are not fully substantiated we should to some extent agree with him.

* The fact that the mean cephalic indices of all the longest series of Englishmen that have been measured (see a list given by Pearson and Tippett, *Biometrika*, Vol. xvi. 1924, p. 131) are all close to 78 may indicate descent from either the Iron Age or the Anglo-Saxon populations—the mean index of the living head being supposed as usual about 2·5 points greater than that of the skull—but the value 78 confirms the conclusion suggested by the cranial measurements that the extremely dolichocephalic Neolithic and the brachycephalic Bronze Age types were either exterminated or absorbed by the later races, without leaving any sensible impress upon them.

ON THE COEFFICIENT OF RACIAL LIKENESS.

By KARL PEARSON, F.R.S.

Every craniologist and indeed every physical anthropologist has come up against the difficulty of comparing two races of which it is only possible to secure a limited number of individuals of one or other or both races. Not unnaturally he is driven under the circumstances to seek help by measuring a large number of characters in order to compensate for few individuals*. We have frequently to admit that relatively few individuals are available in many anthropometric inquiries, and that we really must compensate for the smallness of our sample by the largeness of our character series. But how is this to be done? We can compare the means for our two small groups character by character, and if we are trained statisticians we shall compare these mean differences with their standard deviations. But when a considerable number of the characters do not show differences markedly significant with regard to their probable errors, we are left in considerable doubt as to what inference may be safely drawn from the whole series. We need a single numerical measure of the whole system of differences, something which will express by a single coefficient the measure of resemblance (or divergence) of the two races or groups. Such a measure or coefficient I term a *Coefficient of Racial Likeness* (C.R.L.). It should be a measure, not of how far the two races or tribes are alike or divergent, but of *how far on the given data* we can assert significant resemblance or divergence.

Let us suppose m_s to be the mean in the first group of the sth character, σ_s its standard deviation and n the size of the sample; let m_s', σ_s' and n' be the corresponding quantities for the second sample. Then the difference of the means will be $m_s - m_s'$ and, supposing as will be the fact for proper random sampling that m_s is not correlated with m_s', the standard deviation of the difference will be $\sqrt{\frac{\sigma_s^2}{n} + \frac{\sigma_s'^2}{n'}}$. Similarly for a second character t we have to compare $m_t - m_t'$ with

$$\sqrt{\frac{\sigma_t^2}{n} + \frac{\sigma_t'^2}{n'}}.$$

Now if we are really taking samples from the *same* population, the mean of all m_s's and of all m_s''s will be the same, or the mean value of $m_s - m_s'$ or of $m_t - m_t'$ will be zero. Further, the distribution of difference of means will be like the dis-

* I have known cases in which an anthropologist has measured 50 to 100 characters in the 20 to 30 individuals of one tribe and sex, who were accessible to him, and he has pressed me to tell him whether this group was distinguishable from a similar small sample of a second tribe. Thus the problem is a very real one.

tribution of means themselves (if there be no association of the samples), closely normal whatever the original population may be, and will be the more rapidly normal as the size of the sample increases if the original population be, as it actually is in most anthropometric series, approximately normal. Accordingly each series like $m_s - m_s'$ will be given by a normal curve with S.D. equal to $\sqrt{\frac{\sigma_s^2}{n} + \frac{\sigma_s'^2}{n'}}$. All these normal curves will be reduced to one and the same scale if we take as our variate

$$X_s = (m_s - m_s') \Big/ \sqrt{\frac{\sigma_s^2}{n} + \frac{\sigma_s'^2}{n'}},$$

i.e. the variation of the X_s's will be about the origin of a normal curve with standard deviation unity.

If then we could consider X_s, X_t, etc. as independent characters, each would be a random drawing from a normal population of standard deviation unity; and if we took M, such drawings

$$\Sigma = \left\{\frac{1}{M} S\left(\frac{(m_s - m_s')^2}{\frac{\sigma_s^2}{n} + \frac{\sigma_s'^2}{n'}}\right)\right\}^{\frac{1}{2}}$$

should within the error of random sampling approach the value unity.

And further

$$\Sigma^2 = \left\{\frac{1}{M} S\left(\frac{(m_s - m_s')^2}{\frac{\sigma_s^2}{n} + \frac{\sigma_s'^2}{n'}}\right)\right\}$$

should also approach the value unity. We may adopt either of these values we please, but we shall have a difference in the probable error of our result according to our choice of Σ or Σ^2 to be dealt with.

Now what we are really doing here is to sample from a variate X (i.e. values $X_1, X_2, \ldots X_s, \ldots X_t, \ldots$), which is distributed normally, and determining its standard deviation or its standard deviation squared. The distribution of both of these are known and accordingly their probable values, mean values and standard deviations.

The curve for the distribution of Σ is

$$y = y_0 \Sigma^{M-2} e^{-\frac{1}{2}M\Sigma^2},$$

and the most probable value of Σ is

$$\tilde{\Sigma} = 1 - \frac{2}{M},$$

while the standard deviation of Σ is

$$\sigma_\Sigma = \sqrt{\frac{2}{M}\left(\frac{M-1}{2} - \left\{\frac{\Gamma(\frac{1}{2}M)}{\Gamma(\frac{1}{2}(M-1))}\right\}^2\right)}^{\frac{1}{2}}$$

$$= \frac{1}{\sqrt{2M}}\left(1 - \frac{1}{8M}\right),$$

approximately.

If M be large it will be adequate to suppose the distribution of Σ to be normal; for practical purposes this may be supposed reached by $M = 20$*, in which case we may take $\sigma_\Sigma = \frac{1}{\sqrt{2M}}$ and represent our result as

$$(\text{C.R.L.})_1 = \left\{ S\left(\frac{1}{M} \frac{(m_s - m_s')^2}{\frac{\sigma_s^2}{n} + \frac{\sigma_s'^2}{n'}} \right) \right\}^{\frac{1}{2}} - 1 \left[+ \frac{2}{M} \right] \pm \frac{\cdot 67449}{\sqrt{2M}} \quad \ldots\ldots\ldots\text{(i)},$$

the value of C.R.L. varying round zero, if the two groups are from the same race with the probable error $\cdot 67449/\sqrt{2M}$. As a rule the races are sufficiently divergent to make the term $\left[+ \frac{2}{M} \right]$ of small importance; for twenty characters it only contributes $\cdot 1$, while it is the whole digits which have really to be considered.

If we prefer to deal with Σ^2 instead of Σ, the curve for its distribution is

$$y = y_0 (\Sigma^2)^{\frac{M-3}{2}} e^{-\frac{1}{2}M\Sigma^2}.$$

Here the most probable value of Σ^2 is

$$(\tilde{\Sigma}^2) = 1 - \frac{1}{M},$$

and the standard error σ_{Σ^2} is given by

$$\sigma_{\Sigma^2} = \sqrt{\frac{2}{M}\left(1 - \frac{1}{2M}\right)},$$

approximately.

Accordingly:

$$(\text{C.R.L.})_2 = S\left\{ \frac{1}{M} \left(\frac{(m_s - m_s')^2}{\frac{\sigma_s^2}{n} + \frac{\sigma_s'^2}{n'}} \right) \right\} - 1 \left[+ \frac{1}{M} \right] \pm \cdot 67449 \sqrt{\frac{2}{M}} \quad \ldots\ldots\text{(ii)},$$

where the value of C.R.L. will vary round zero with a probable error of

$$\cdot 67449 \sqrt{\frac{2}{M}}.$$

Either value of C.R.L. might be taken as our standard measure of racial resemblance, and I considered both in 1919, and preferred the second, because the term in square brackets could be more frequently neglected. But unfortunately it appeared in *Biometrika*, Vol. XIII. p. 248, with the probable error of (i), i.e. $\frac{\cdot 67449}{\sqrt{2M}}$, instead of (ii), i.e. $\cdot 67449 \sqrt{\frac{2}{M}}$, and this slip has been perpetuated in craniometric papers since. I did not notice the slip till reading through the proofs of Miss Hooke's paper in the current number. The slip is corrected in that paper and also in those of Mr Morant, and of Mr Morant and Miss Hooke in this issue.

* See Table, *Biometrika*, Vol. x. p. 529.

In the papers on the Tibetan*, Nepalese† and Egyptian‡ crania by Mr Morant and on the Burmese crania by Miss Tildesley§, the probable errors of the C.R.L. require *doubling*. This error, however, makes no difference in the conclusions drawn, for the probable error is merely intended to enable an appreciation to be made of how far the intensity of the coefficient is influenced by random sampling and how far by the fact that the two groups compared belong to markedly different races. In nearly all cases dealt with, even in comparing English with English, it is seen at once that the coefficient is influenced in the first place by the differential characterization and not by the sampling, which is of a quite secondary order.

We must halt, however, here to remark on another important point. σ_s and σ_s' are supposed to be the standard deviations of the sth character in the two populations of which our groups are respectively samples. They do not therefore vary with the sample or contribute to the probable error of C.R.L. But unfortunately we do not know σ_s and σ_s' and if we determine them from our samples, which *à priori* are supposed somewhat small, they will have large probable errors. Indeed the determination of variability from small samples constantly leads to larger divergences between the variability in the two samples than exists between the variabilities of two different races based on adequate numbers. For this reason I concluded that it would be unwise to use the values of σ_s and σ_s' derived from the small samples themselves, but that it would, having regard to the fact that the different races of men are not widely divergent in variability, be best to use the system of standard deviations obtained from large numbers, rather than those from the small samples under immediate consideration. For this purpose I selected the 1700 Dynastic Egyptian skulls which had been measured in the Laboratory and gave reasonable values of the standard deviations based on 700 to 800 crania of each sex. The formula then simplifies to

$$\text{C.R.L.} = S\left(\frac{1}{M}\frac{nn'}{n+n'}\frac{(m_s - m_s')^2}{\sigma_s^2}\right) - 1\left[+\frac{1}{M}\right] \pm \cdot 67449\sqrt{\frac{2}{M}},$$

where σ_s^2 is the variance of the sth character in the standard population.

If the series of either group be sufficiently long, as in the case of the Farringdon Street English, then we may use the σ_s's as found from it, but for the special case for which the C.R.L. was devised, where n and n' are relatively small, and this smallness is to be compensated by measuring many characters M, this is unwise. It is better, I think, to use the idea of a general human variability, slightly modified from one race to a second, than to increase the random errors of our coefficient by making crude approximations to the variabilities of the unknown populations from our small samples themselves.

Another and most important aspect of the matter now arises for consideration. Let us suppose the means of the sth character in the two sampled populations to

* *Biometrika*, Vol. XIV. pp. 207 *et seq.*
† *Biometrika*, Vol. XVI. pp. 54—73.
‡ *Biometrika*, Vol. XVII. pp. 1—52.
§ *Biometrika*, Vol. XIII. pp. 248—351.

be $\overline{m}_s$ and $\overline{m}_s'$ respectively. We can write $m_s = \overline{m}_s + \delta\overline{m}_s$ and $m_s' = \overline{m}_s' + \delta\overline{m}_s'$, where $\delta\overline{m}_s$ and $\delta\overline{m}_s'$ are statistical differences and not infinitely small mathematical differentials. Accordingly we have

$$\begin{aligned}\text{C.R.L.} = {} & S\left\{\frac{1}{M}\,\frac{nn'}{n+n'}\cdot\frac{(\overline{m}_s-\overline{m}_s')^2}{\sigma_s^2}\right\}\\ & + 2S\,\frac{nn'}{M}\left\{\frac{(\overline{m}_s-\overline{m}_s')}{(n+n')\,\sigma_s^2}\right\}\delta\overline{m}_s\\ & - 2S\left\{\frac{nn'}{M}\,\frac{\overline{m}_s-\overline{m}_s'}{(n+n')\,\sigma_s^2}\right\}\delta\overline{m}_s'\\ & + S\left\{\frac{1}{M}\,\frac{nn'}{n+n'}\,\frac{(\delta\overline{m}_s)^2}{\sigma_s^2}\right\} + S\left\{\frac{1}{M}\,\frac{nn'}{n+n'}\,\frac{(\delta\overline{m}_s')^2}{\sigma_s^2}\right\} - 2S\left\{\frac{1}{M}\,\frac{nn'}{n+n'}\right\}\delta\overline{m}_s\,\delta\overline{m}_s' - 1.\end{aligned}$$

Now when we take the mean value of all these summations for a large number of samples, the first is a constant and does not vary, the second and third vanish because the mean value of $\delta\overline{m}_s$ and $\delta\overline{m}_s'$ is zero, the mean value of $(\delta\overline{m}_s)^2$ is σ_s^2/n and of $(\delta\overline{m}_s')^2$ is σ_s^2/n', while lastly the mean value of $\delta\overline{m}_s\,\delta\overline{m}_s'$ is zero, for they are uncorrelated. Thus the mean value of the terms in $(\delta\overline{m}_s)^2$ and $(\delta\overline{m}_s')^2$ is $S\left(\frac{1}{M}\right)=1$, which cancels with the -1, and we see that the main component of the C.R.L. is the term $S\left\{\frac{1}{M}\,\frac{nn'}{n+n'}\,\frac{(\overline{m}_s-\overline{m}_s')^2}{\sigma_s^2}\right\}$, that is it is determined by the difference in the means of the sampled populations. It is really these $\delta\overline{m}_s$, $\delta\overline{m}_s'$ which give rise to the variability of the C.R.L. when we take continuous pairs of samples, and which is expressed by the probable error. It is thus not likely, unless the means are the same for all corresponding characters in the two sampled populations, that the C.R.L. will be zero. It is easily shown from a slight experience in comparing data for various races that the variations expressed in $\delta\overline{m}_s$, $\delta\overline{m}_s'$ (σ_s^2 being considered constant) contribute little to the value of the C.R.L.; that depends for its intensity on the fundamental term

$$S\left\{\frac{1}{M}\,\frac{nn'}{n+n'}\,\frac{(\overline{m}_s-\overline{m}_s')^2}{\sigma_s^2}\right\}.$$

The question may of course be raised, whether another and better expression might not be found as a coefficient of racial likeness. It may be quite well argued that product terms ought to be introduced into its expression. We know that while m_s is not correlated with m_s', yet m_s is correlated with m_t, in fact if we are taking a series of samples from the same two populations the correlation between m_s and m_t is r_{st} and between m_s' and m_t' will be r_{st}', where r_{st} and r_{st}' are the correlations of the sth and tth characters in the two populations themselves*. Now it would not be unreasonable to suppose that just as we have taken $\sigma_s=\sigma_s'$ we may also take approximately $r_{st}=r_{st}'$. In this case it is easily shown that

$$\frac{nn'}{n+n'}\,\frac{(m_s-m_s')\,(m_t-m_t')}{\sigma_s\sigma_t}$$

* The correlation coefficient of the mean of two variates is the same as the correlation coefficient of the two variates themselves.

takes for its mean value

$$\frac{nn'}{n+n'}\frac{(\overline{m}_s-\overline{m}_s')(\overline{m}_t-\overline{m}_t')}{\sigma_s\sigma_t}+r_{st}.$$

As in the case of $\frac{nn'}{n+n'}\frac{(m_s-m_s')^2}{\sigma_s^2}$ it will probably be the first term in this expression which provides the chief contribution. Although some characters of the skull are fairly highly correlated, others have hardly any correlation at all, and some may have positive and some negative signs.

If, however, we start with our variates

$$X_s=\sqrt{\frac{nn'}{n+n'}}\frac{m_s-m_s'}{\sigma_s},\quad X_t=\sqrt{\frac{nn'}{n+n'}}\frac{m_t-m_t'}{\sigma_t},$$

and *suppose our two samples to belong to the same population*, then we have $\sigma_{X_s}=1$, $\sigma_{X_t}=1$ and $r_{X_sX_t}=r_{st}$. Hence if we form the determinant

$$R=\begin{vmatrix} 1, & r_{12}, \ldots\ldots & r_{1M} \\ r_{21}, & 1, \ldots\ldots & r_{2M} \\ \ldots\ldots & \ldots\ldots & \ldots\ldots \\ \ldots\ldots & \ldots\ldots & \ldots\ldots \\ r_{M1}, & r_{M2} \ldots\ldots & 1 \end{vmatrix}$$

and its minors, we should have

$$\chi^2=\frac{1}{R}\left\{\sum_1^M S(R_{ss}X_s^2)+2S'(R_{st}X_sX_t)\right\},$$

and our distribution surface with an element $z_0e^{-\frac{1}{2}\chi^2}\,dX_1\,dX_2\ldots dX_M$ of frequency. This would lead us to a χ^2, P test of the improbability of the material of the two groups being drawn from the same population, which might well be better theoretically than the C.R.L. discussed previously. Now it will be seen that in order to get the value of R and its minors we must know the correlations of M characters in a standard population. The ideal value of M would be 40 to 50, this would involve the calculation of 780 or 1225 correlation coefficients. The largest number of correlation coefficients yet computed are those for the Egyptian 26th to 30th Dynastic series. But in that case after very strenuous labour only 312 correlations were found. Thus, if the particular characters there chosen had been so chosen as to give a closed series, i.e. if 24 or 25 characters had been selected and correlated only among themselves, we could only take $M=24$ or 25 and must *always* take the same 24 or 25 characters, whatever pairs of races were being compared. This is an impossibility unless all craniologists agree to consider the same standard characters. But suppose this were done, and that there were 30 to 40 standard characters and the 435 to 780 correlations were all known, then indeed the real difficulty of the task would begin, we should have to compute a series of determinants, 780 to 820 in number, each consisting of 30 to 40 rows and columns. The task would be gigantic and if completed would be of no service should a series of crania be measured in which even one of the standard characters had been omitted. For the statistician, as for the statesman, the ideally

best is not always the wisest course. Even if these coefficients could be computed, we should have to deal with the determining and adding together of 465 (30 + 435) to 820 (40 + 780) terms instead of the 30 to 40 terms of the present cruder coefficient. Further, while some of these terms are positive others are negative, and the great bulk, although by no means all, are very small*. Hence the 435 to 780 terms may not contribute as much as we might possibly anticipate to the 465 to 820 terms suggested for our χ^2. The mean correlation of the characters of the skull—without regard to sign—is only about ·3, and would be considerably less paying attention to sign. Still the fundamental weakness of the Coefficient of Racial Likeness lies in the fact that it neglects the correlations between the characters dealt with. If we examine such determinantal relations as R_{ss}/R and R_{st}/R, we see that

$R_{ss}/R = 1 -$ squares and higher powers and products of correlations,

$R_{st}/R = r_{st} -$ products and higher powers and products of correlations,

$= 1 - \Delta_{ss}$ and $r_{st} - \Delta_{st}$, say, respectively.

I have found it possible to express Δ_{ss} and Δ_{st} as approximate functions of *mean* correlation values, but I have not been able to determine how close this approximation is in the case of 15 to 20 rowed determinantal ratios without numerical experiment, the labour of which would be very great. But were these approximate expressions adequate in the case of cranial correlations, I cannot conceive that any craniologist could at present be induced to calculate the hundreds of correlations requisite (i.e. the r_{st}'s), or having found them to compute the hundreds of terms requisite to determine χ^2.

However, I do see an entirely different method of approaching the subject when once we have 50 to 100 cranial series, each containing 50 to 100 individuals of one sex measured in a standardised manner. But that method is for co-operative work in the future.

Meanwhile the C.R.L. as now in use seems to me the best test available, if used with discretion, i.e. tested in male and female series, and for indices and angles, as well as for all characters, and compared in its results with conclusions drawn from the correspondence or divergence of the mean racial cranial contours†. If any one has a sounder coefficient to propose, I shall not be the last to welcome and use it.

Assuming, however, that the theoretical difficulties of the C.R.L. can be disregarded, and that it can be looked upon as *practically* an approximate measure of racial association, if not an ideally adequate one, we may ask: how has it fulfilled this purpose? Does it give on the whole a rough measure of racial likeness, when we classify races by the general impressions which anthropologists have hitherto adopted rather than by accurate numerical relations? On the whole, while it contradicts some current anthropological beliefs, and suggests some

* See, on all these points, the paper by Pearson and Davin, "Biometric Constants of the Human Skull," *Biometrika*, Vol. XVI. pp. 347—363.

† A single number to represent the degree of resemblance between two mean racial cranial contours is badly needed.

hitherto unsuspected relationships, it does not give results wildly discordant with the beliefs and impressions of anthropology. It seems rather to confirm, to extend and in special cases to correct them.

Up to the present nearly 760 C.R.L.'s have been determined by the Biometric School of craniometry. It was considered originally possible that there might be a resemblance in shape between two races, when there failed to be a resemblance in absolute size. For this reason C.R.L.'s were worked out for indices and angles only; of these we have 340, while for absolute measurements, angles and indices, i.e. for characters of all types combined, we have 417 cases. It was actually found that in certain cases there was a greater resemblance in shape than size, but it may be doubted whether it is worth while to separate size and shape characters, as this of course lessens the total number of characters available for computing the coefficient. We prefer to use two series only, one for shape characters and one for *all* characters.

The following table gives the distribution of coefficients found:

Values of C.R.L.'s.

Less than *1* ...	*1—4*	*4—7*	*7—10*	*10—13*	*13—16*	*16—19*	*19—22*	*22—25*	*25—28*	*28—31*	Above *31*	Totals
All Characters 54	131	73	39	26	23	15	12	8	11	2	23	417
Indices and Angles 56	106	59	35	19	16	9	12	4	6	2	16	340
Totals 110	237	132	74	45	39	24	24	12	17	4	39	757

Of course the main object of the biometric inquirers was to find resemblances, not to search for widely divergent races. Hence no special stress is to be laid on the frequency distributions, but knowing the races involved in each group of values it seemed possible to arrange a classification giving five grades of association and seven grades of divergence, and after stating these—at any rate as provisional terms—we will then consider what pairs of races fall into some of these categories.

Degrees of Association			Degrees of Divergence		
Grade	Range	Class	Grade	Range	Class
I	Less than *1*	Very intimate Association	I	*13—16*	Slight Divergence
II	*1— 4*	Close Association ...	II	*16—19*	Moderate Divergence
III	*4— 7*	Moderate Association ...	III	*19—22*	
IV	*7—10*	Slight Association ...	IV	*22—25*	Marked Divergence
V	*10—13*	Doubtful Association ...	V	*25—28*	
—	—	—	VI	*28—31*	
—	—	—	VII	Over *31*	Very wide Divergence

Of course, assuming the origin of man to be monogenetic, "Association" and "Divergence" are only relative terms of a continuous grade of relationship, indicating only the greater length of differentiated ancestry. But they are convenient terms. It is proper to look upon Anglo-Saxons and modern English as associated races, but on Chinese and English as divergent races, if we only mean by this that the forerunners of Chinese and English diverged much earlier from a common ancestry than English and Anglo-Saxons. To fix the limit of association and divergency at a C.R.L. = 13 is of course arbitrary, but it is convenient for practical purposes. It signifies that it would be difficult to place two races with this coefficient in the same family of races.

I will examine individually first some of the pairs which fall into my "Very wide Divergence" category. They are, considering only all characters:

The Dravidian Race as represented by the Maravar with Malays (31), with Burmese (38), with English (Whitechapel) (43), with Moriori (49), and with Aino (55). We should *à priori* probably have asserted all these races to be widely divergent, but in this marked divergence that the Malays and Burmese should be less marked is satisfactory, if again it be what some might anticipate*.

The Aino race with Tibetans (31), with Hindus (32), with Malayans (33), with Moriori (33), with Burmese (34), with English (35), with Nepalese (38), with Dravidians (55), and with Altai Telengites (71)†.

English 17th Century with Nepalese (35), with Burmans (46), and with Malays (77); the Prehistoric Egyptians (Naqada) with Burmans (55), and with Malayans (65); the Moriori with the Hindus (32) and with the Nepalese (33) are all self-explanatory. We are dealing with races which every one admits to be widely divergent. In practically all these cases our results are confirmed, if we limit our characters to indices and angles only. There are indeed some cases in which for shape only the divergence is more conspicuous than when we deal with both size and shape. Thus:

Eskimos with Maori (32), with Fuegians (35) with Moriori (51), with Aino (64); while for both size and shape the corresponding values are: (13), (20), (25) and (26) respectively. These connote rather considerable divergence but not so great as for shape only. We get measures of wide divergence if we deal with shape only in the case of the Malayans, e.g. with Aino (37), with Moriori (37), with Prehistoric Egyptians (110), and with 17th Century English (126). In all these cases we are dealing with what are admittedly widely divergent races. A very limited craniological experience would enable anyone to distinguish without computing a C.R.L. between the skulls of the last races. But we have cited the values here to show that the C.R.L. is a real criterion of cranial divergence.

It would not be fair, however, to pass by two remarkable values wherein the C.R.L. appears at first to fail. The skulls at Hythe have been measured to the

* It is easy to find races closely allied to this Dravidian stock, thus with Bengal Hindus (2), with Veddahs (2), with Andamanese (5), with Nepalese (6·5), with Burmese Hybrids (7), and with Karens (10).

† Again it is easy to find out associated races: with Fuegians (7), with Japanese (8), with Maori (8), with Koreans (9), and with Northern Chinese (16).

number of 315 by Professor Parsons, unfortunately for very few characters. Only eight are available for a C.R.L. They have been compared with the 17th Century English (Farringdon Street) (83) and with the Anglo-Saxons (73). These numbers indicate either (i) that the Hythe crania are very widely divergent from English and Anglo-Saxon, or (ii) that Professor Parsons' methods of measurement are very widely divergent from those laid down by the international concordat. Until the Hythe crania are measured for a large variety of characters in the standardised manner it will be impossible to say what is the real significance of the above C.R.L.'s.

If we now turn to the other extreme of our scale "very intimate association," we find ourselves dealing with: (*a*) the same race sampled by two craniologists, (*b*) local varieties of the same race, or (*c*) the same race at different epochs of its existence. Of course all cases of (*a*), (*b*) and (*c*) do not fall into Grade I of Association, but it is difficult to find any pair in Grade I which we are certain embraces two craniologically distinct races. A few examples of each class will suffice: (*a*) Eskimos measured by Fürst and Hansen, and those measured by Hrdlička (– 0·90), two series of Chinese (0·59), Moriori—Scott's series and Thomson's series—(0·41), Trans-Himalayan and Cis-Himalayan Bhotias (– 0·34) Nepalese Central and Nepalese Eastern (– 0·45), etc. The last two cases probably might be classified under (*b*). (*b*) Tibetans and Trans-Himalayan Bhotias (0·48), Burmans and Burmese Hybrids (0·78), Annamese and Southern Chinese (0·01), Siamese and Annamese (0·14), Torgods and Kalmucks (0·89), etc. (*c*) 17th Century English (Whitechapel) and British Iron Age (0·38), 1st and 2nd Dynasty (Royal Tombs) and 18th—20th Dynasty (0·9), Ptolemaic Period and Roman Period Egyptians (0·72), 1st and 2nd Dynasty Royal Tombs and Roman Period Egyptians (0·65), Prehistoric Egyptians (Naqada) and Ptolemaic Period Egyptians (0·04), etc.

The above illustrations of the two extremes of "marked divergence" and "intimate association" prepare us for having confidence in the C.R.L. in the intermediate grades.

Once this confidence is won—and those who have examined the 750 coefficients already computed will find in them confirmation of many conclusions reached in other ways—we cannot reject straight off results which are novel or against impressions often based on no well-defined quantitative research. I may mention one or two of these results, which I believe should not be straight off rejected, but deserve full consideration.

(i) The Moriori are more closely related to the Fuegians (4·6) than to the Maori (8·5). This may indicate an early transfer from Antarctic lands to South America.

(ii) The Aino are more closely related to the Fuegians (6·7) than to the Japanese (8·1), or to the Koreans (8·9), or to the Northern Chinese (16·1). A study of "fringe" peoples by aid of the C.R.L. may lead us to new ideas on the passage of human racial waves over the whole earth's surface. The presence of Lemuroids

in Borneo and Madagascar led to strange hypotheses, until the fossils of Lemuroids were found in Europe, Asia, and America.

(iii) The crania of modern Abyssinians of the Tigré District are as closely related to Dynastic Egyptians (1·2 to 3·7) as the Dynastic are to the Predynastic Egyptians. The ancient Egyptian type has therefore been preserved in more than one form to modern days.

(iv) The English skull is nearer to that of the men of the British Iron Age than to that of Anglo-Saxons. Thus

17th Century English		Men of Iron Age	Anglo-Saxons
Males	Whitechapel Crania ...	(0·38)	(2·98)
	Moorfields Crania ...	(1·55)	(4·88)
	Farringdon Street Crania	(2·82)	(5·27)
Females	Whitechapel Crania ...	(1·84)	(9·61)
	Moorfields Crania ...	(1·32)	(4·66)
	Farringdon Street Crania	(2·81)	(6·51)

It will be evident from these figures that though the Anglo-Saxon is associated with the English skull, it stands in nothing like so close a relationship as the skull of the Iron Age men. Nor indeed is the Anglo-Saxon closer to the English than the Long Barrow cranium as measured by Schuster, which gave with Whitechapel (3·7) and with Farringdon Street (5·3).

If the coefficient of racial likeness is to be trusted, the belief that the English are in the main Anglo-Saxons must be discarded. This does not mean that there is not association of a "moderate" kind with the Anglo-Saxons—it is closer than the "doubtful association" of Bavarians with Würtemberger (12·1) or than the "marked divergence" of English and French (24·5)—but it is not of the "close association" type which the English have with men of the Iron Age (Grade II of Association).

I have said enough to indicate that not only the C.R.L. can confirm current impressions, but that it can raise new and suggestive problems. With the work done in the Biometric Laboratory by Miss M. Tildesley, Mr Morant and Miss B. Hooke we are now in a position to state that the coefficient can be a serviceable tool in craniometric research. Such a statement was not possible when the coefficient only stood on a not wholly adequate theoretical basis, but the present practical basis of 750 computed coefficients, capable of being set against many accepted racial relations, has given it a sounder position, and this we owe entirely to their assiduous labour.

The change in the C.R.L. can be illustrated in reference to the number of characters dealt with by comparing a few cases in which it has been calculated for two series of characters on the same series of crania.

Thus we have:

Series compared	Number of Characters	
Naqada *A*, *Q* Graves with Naqada *B*, *T*, *R* Graves	14 (1·62)	31 (0·65)
Modern Abyssinian with El Kubanieh South Graves	14 (1·16)	23 (1·87)
Naqada *B*, *T*, *R* Graves with 1st Dynasty Royal Tombs	14 (2·59)	31 (2·37)
El Kubanieh South Graves with 18th—21st Dynasty Tombs ...	14 (3·51)	27 (2·65)
Naqada *A* and *Q* Graves with 1st Dynasty Royal Tombs ...	14 (9·68)	31 (6·36)

While the experienced craniometrician would lay no real stress on the differences in the C.R.L. occurring between those with long and those with short series of characters—especially as the numbers of crania involved were not large—it might appear as if the longer series of characters involved in general a smaller value of the C.R.L. To test this point I took out of the 417 coefficients for all types the 313 for which the number of characters used was directly stated, and formed a correlation table for size of coefficient and number of characters used. The resulting table was somewhat "lumpy" owing to necessity or preference leading the biometric workers to adopt certain groups of characters, but I think the final result may be relied on. It is:

Correlation of the C.R.L. and Number of Characters used

$$r = \cdot 0527 \pm \cdot 0380.$$

In other words there is no evidence that the coefficient of racial likeness is influenced in one direction by the number of characters adopted. I think this must really *à priori* be obvious, if no selection has been made of those characters which in the two races differ most or differ least from one another.

I next proceeded to consider what influence the number of individual crania dealt with had on the coefficient. Considering only coefficients based on all characters (i.e. absolute size and indices and angles), I obtained a correlation table of 580 entries, entering each coefficient twice, once for each race dealt with. The table was still more "lumpy" than the previous one, as the skull frequencies run from 6 to 885. The answer I found for the Correlation of the C.R.L. and Number of Crania used was

$$r = + \cdot 1270 \pm \cdot 0276,$$

i.e. there was a not very important correlation between the number of skulls used and the coefficient, the *greater* the number of skulls the *larger* the coefficient. As a matter of fact the influence of the size of the two samples is largely obscured by the variation of the ratio $(\overline{m}_s - \overline{m}_s')^2/\sigma_s^2$ (see our p. 109). Thus we see that the actual values of n and n', the numbers of individuals in the two series compared, is not so influential as might have been anticipated. It would undoubtedly be well if n and n' as well as the cranial characters selected could be standardised. We should then make far more rapid progress in placing the various races of man into a classified scheme and seeing more clearly the nature of human evolution.

What we need are, say 50 to 100 crania of each sex of each race, and then 40 to 50 characters measured in a standardised manner. I think the C.R.L., as it has been already used, forms a very good rough guide to racial association—or in some few cases, perhaps, to the extraordinary personal equations of certain craniologists—but if we had such series as I have suggested its value would be markedly emphasised. Owing to the steady measuring and tabling work of German and English investigators, such long series for an adequate number of characters are becoming greater in number and they will one day form a sound basis for a theory of racial evolution in man. Any argument from series of 6 to 10 crania—even using the C.R.L.—is, I think, to be deprecated*. It may be all that is feasible at present, but conclusions based on such series cannot be treated as final.

* I noted that out of the 580 coefficients tabled by me nearly a sixth, 94, were for series with less than 16 crania measured.

REMAINS OF SAINT MAGNUS AND SAINT ROGNVALD, ENTOMBED IN SAINT MAGNUS CATHEDRAL, KIRKWALL, ORKNEY.

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Owing to the courtesy of the Magistrates of Kirkwall, Orkney, trustees of the bequest of the late Sheriff Thoms for the restoration of Saint Magnus Cathedral in Kirkwall, Orkney, the privilege was granted to me of examining, in August 1925, the remains of two human skeletons entombed in two of the pillars of that cathedral.

These skeletal remains were supposed to be those of Saint Magnus and Saint Rognvald, two famous Norse Saints, whose life histories formed the main theme of the Orkneyinga Saga.

The object of the examination was to decide, if possible, whether this supposition might be accepted as verified, and if so, to make an anthropological record of the skeletal remains of two celebrated Norsemen who had both been canonized in the twelfth century.

The only means of attaining this object was by an investigation of the history of these individuals, in so far as it could be obtained from the Orkneyinga Saga and other relative documents, and by associating the facts so ascertained with the physical appearances presented by the skeletal remains and the locations in the cathedral in which they were found.

History.

Magnus was the son of Erlend, Joint-Earl of Orkney. Erlend held his Earldom from the King of Norway and died in Norway about the close of the 11th century. Magnus was described in a somewhat imaginative strain as being "Of large stature, a man of noble presence and intellectual countenance" (1). At first he ruled Orkney conjointly with his cousin Hakon, but after some time dissensions arose between them, with the result that Magnus was slain by order of Hakon, on the island of Egilshay in 1115. His day in the Roman Calendar is 16th April.

As the manner of his death had an important bearing upon the identification of the skeletons, the following extract from the Orkneyinga Saga may be quoted: "Then when God's friend (Magnus) was led to execution he said to Lifolf (executioner), 'Stand before me and hew me a mighty stroke on the head, for it is not fitting that high-born lords should be put to death like thieves. Be firm, poor man, for I have prayed God for you, that he may have mercy upon you'" (2).

"After that Earl Magnus signed himself with the sign of the Cross and bowed him to the stroke, but Lifolf hewed him on the head a great blow with an axe. Then Earl Hakon said, 'Hew him a second time.' Then Lifolf hewed into the same wound. Then Saint Magnus the Earl fell on his knees and fared with this martyrdom from the wretchedness of this world to the everlasting bliss of the kingdom of heaven" (3).

Another passage from the Saga is also of interest: "The place where Earl Magnus was slain was previously covered with moss and stones, but shortly afterwards his merits before God became manifest in this wise that it became greensward where he was beheaded" (4).

As a consequence of the entreaties of his mother, his body was buried in a coffin in the ground in Christ's Kirk, Birsay, and after lying twenty years there it was placed in a shrine which was "set over the altar" of that church. The shrine with its contents was thereafter removed to Saint Olaf's in Kirkwall and it was described as "set over" the altar of that church (5). It was then transferred to the Cathedral in Kirkwall when that edifice was ready to receive it (6).

Hakon after repenting of his evil deeds went upon a pilgrimage to Rome and Jerusalem and returned to Orkney where he promoted all the arts of peace and died beloved and respected by his people.

He was succeeded by his two sons, Paul and Harald. The latter was mysteriously done to death; the former was kidnapped by Swein, Asleif's son, and taken to Scotland, his ultimate fate being uncertain.

Rognvald, a nephew of Magnus, now became Earl of Orkney and in fulfilment of a vow he founded a cathedral in Kirkwall in memory of his uncle, Magnus (A.D. 1137). He was described as being "a middle man in growth, well set up, with light brown hair" (7). He was assassinated in Caithness by a stab from a spear, having been previously wounded in the chin by a sword.

His body was brought to Orkney and ultimately buried in the choir of the Cathedral which he had founded (8).

There is thus conclusive evidence that the relics of Saint Magnus and Saint Rognvald were placed in the Cathedral.

It is now necessary to discuss the evidence in favour of the supposition that the bones discovered in the *two pillars* of the Cathedral are those of Saint Magnus and Saint Rognvald. Such evidence has been given with considerable fulness by Mr John Mooney, F.S.A. (Scotland), Kirkwall (9).

It is probable that prior to the extension of the choir eastwards, which was made more than a century after the founding of the Cathedral in 1137, the relics occupied places of honour near the high altar. Before the extension, the high altar stood in close proximity to the pillars in which the relics have been found, and it has been surmised that the relics were subsequently transferred to these pillars when the altar was removed during the extension of the choir. There is, however, no documentary evidence from the early history of the Cathedral as to the date of the transference.

These pillars are represented by the darkly shaded parts of the pillars marked A and B in Fig. 1, the lightly shaded parts corresponding to the additions which had been made during the extension of the choir.

It has been known for several generations locally that there were bones in the third pier from the East on the north side of the choir (A). These were surmised to be those of Saint Magnus. The bones were viewed by the late Marquis of Bute, who rejected the idea that they were those of Saint Magnus, and regarded them as being probably those of Saint Rognvald.

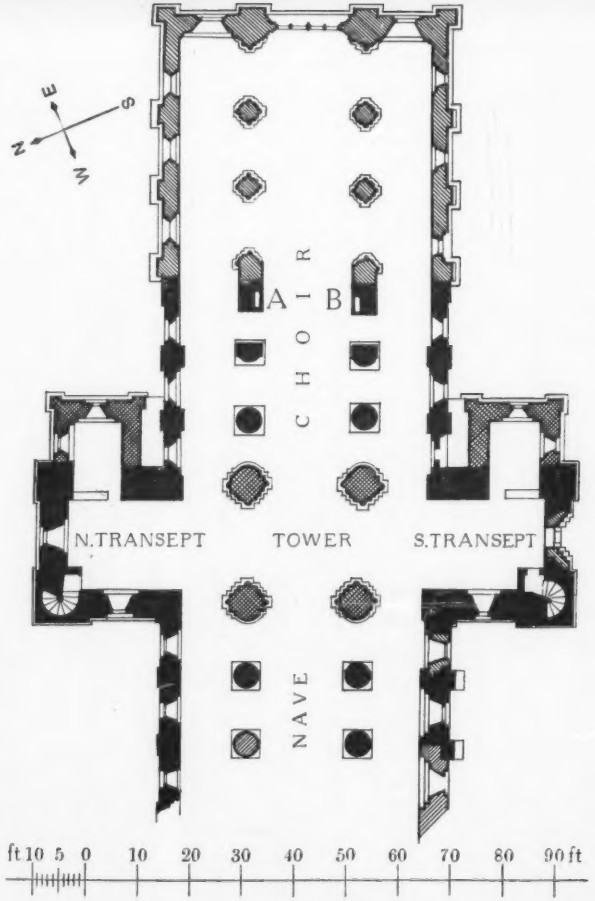
In March 1919 a chest containing bones was discovered in the corresponding pier on the south side of the choir.

It is submitted that the researches embodied in the following paper leave little doubt that they are those of Saint Magnus. Their position in the south pillar corresponds with that of the bones in the north pillar.

On the assumption that the bones in the south pillar (B) are those of Saint Magnus, it seems certain that the bones in the corresponding position on the north side were those of one comparable to him in dignity, and in the veneration of those who placed them there. No other person than Saint Rognvald fulfils these conditions. Saint Magnus and Saint Rognvald were the only saints having a special connection with Orkney. There was no other local canonization. Other early dedications in the country are to Scottish or Irish saints whose disciples as christian missionaries founded churches there, or to Saint Olaf of Norway, who claimed the sovereignty of the Islands. Whether the bones received sepulture in the pillars (A and B) as a token of special honour, or with a view to special security (10), there is no one other than Rognvald to share with Magnus in such honour or solicitude for his relics.

One of the two skeletons now under examination was found along with some fragments of wood in a rudely walled cavity situated in the older part of the pillar marked A, which will be subsequently named, from its position, the *north pillar*. This cavity, which was 9 ft. 6½ in. above the floor of the Cathedral, had evidently been excavated *after* the pillar had been built. It was placed towards the south-west corner of the pillar which flanked the original position of the high altar, Fig. 2.

The other skeleton under examination was found in a more carefully excavated cavity in the older part of the pillar marked B in Fig. 1. This pillar will subsequently be designated the *south pillar*. It was at a distance of 9 ft. 2 in. from the floor of the Cathedral and was placed towards the north-west corner of the pillar which flanked the original position of the high altar. The skeleton was contained in a case made of Scots pine (*Pinus sylvestris*), its sides, top, bottom and ends being held together by wooden pegs. The case practically filled the cavity, and lay with its long axis directed from east to west. The wood was somewhat decomposed at the west end of the case. Its outside dimensions were: length, 74·8 cm. (29½ in.), breadth, 26 cm. (10¼ in.), depth on the average 21 cm. (8¼ in.), and thickness of wood 2·5 cm. (1 in.). The skull lay at the west end of the case with its face directed towards the east.



A indicates position of remains of Saint Rognvald.
B ,, ,, ,, Saint Magnus.
Walls shown solid black, 12th century.
,, crosshatched, late 12th century.
,, hatched, late 13th century.

Fig. 1. Ground plan of part of Saint Magnus Cathedral, Kirkwall, Orkney. Adapted from Dryden's "Illustrations of some parts of the Cathedral-Church, dedicated to Saint Magnus at Kirkwall in Orkney," *Transactions of the Architectural Institute of Scotland*, 1868—1871.

Fig. 2. Sketch of interior of choir of Saint Magnus Cathedral, Kirkwall, Orkney: looking east. Crosses on north and south pillars indicate sites of burial of remains of Saint Rognvald and Saint Magnus.

Remains found in the South Pillar.

The remains found in the case in the south pillar consisted of portions of the skeleton of a man whose age might be roughly estimated as from twenty-five to thirty-five years and of about 171·7 ± 2·03 cm. (5 ft. 7½ in.) in stature, and of six fragments of the limb bones of birds of about the size of geese.

The human remains were: skull (imperfect), lumbar vertebra (imperfect), six ribs (imperfect), left clavicle (imperfect), right and left scapulae (imperfect), right and left humeri (imperfect), right radius (imperfect), left radius, left ulna, three metacarpal bones (imperfect), innominate bone (imperfect), right and left femora (imperfect), left astragalus, right os calcis, right scaphoid, right internal cuneiform, left external cuneiform, left cuboid, third and fourth right metatarsal bones, first, third and fifth left metatarsal bones.

*Skull**. The skull was in a fairly good state of preservation, but the lower jaw was wanting.

In order to facilitate description a comparison was made of the appearances which it presented with those of a modern Scottish skull of a native of an inland parish in Aberdeenshire in the north-east of Scotland, whose measurements represented a blend of the Alpine and Nordic types.

As regards *capacity* the cranium was small. It fell into the mesocephalic group, having a capacity of 1380 c.c. as estimated by the use of shot. It was thus 117 c.c. less than the average 1497 c.c. given by Flower for mixed Europeans (13).

As regards shape of head the cranium was mesaticephalic having a breadth index of 79·3.

Norma verticalis. (Figs. 4, 5, 6, Plate II, Fig. 3.) The superciliary ridges and glabella were indefinitely marked.

The zygomatic arches projected freely from the outline of the cranium. This appearance was in marked contrast to that which was shown in the Aberdeenshire skull where the zygomatic arches did not appear free of the contour of the skull. It was due partly to a narrowing of the frontal bone between the two temporal ridges, and partly to a pronounced sweeping outwards of the arches themselves. The zygomatic breadth was 14·2 cm. as compared with 14·0 cm. in the Aberdeenshire skull, 13·2 cm. as given by Turner for the Scottish, and 14·5 cm. by Hrdlička for Eskimo skulls, the last of which are noted as having a very great distance between their zygomatic arches.

The contour in the occipital regions formed a uniform curve and was slightly more acute than that of the Aberdeenshire skull. The sutures were open with the

* The abbreviations employed in the figures and in Table I were those used by Benington (11) and Morant (12). For list of abbreviations used in the figures see p. 147.

It is important to note that the contours were made by means of the dioptrograph, and that therefore they are not comparable with sectional type contours, since the sectional and the dioptrographic contours taken from the same skull may differ widely, especially in the case of the contour of the norma verticalis, where the contours of the parietal eminences bulge beyond the vertical section through the auricular axis.

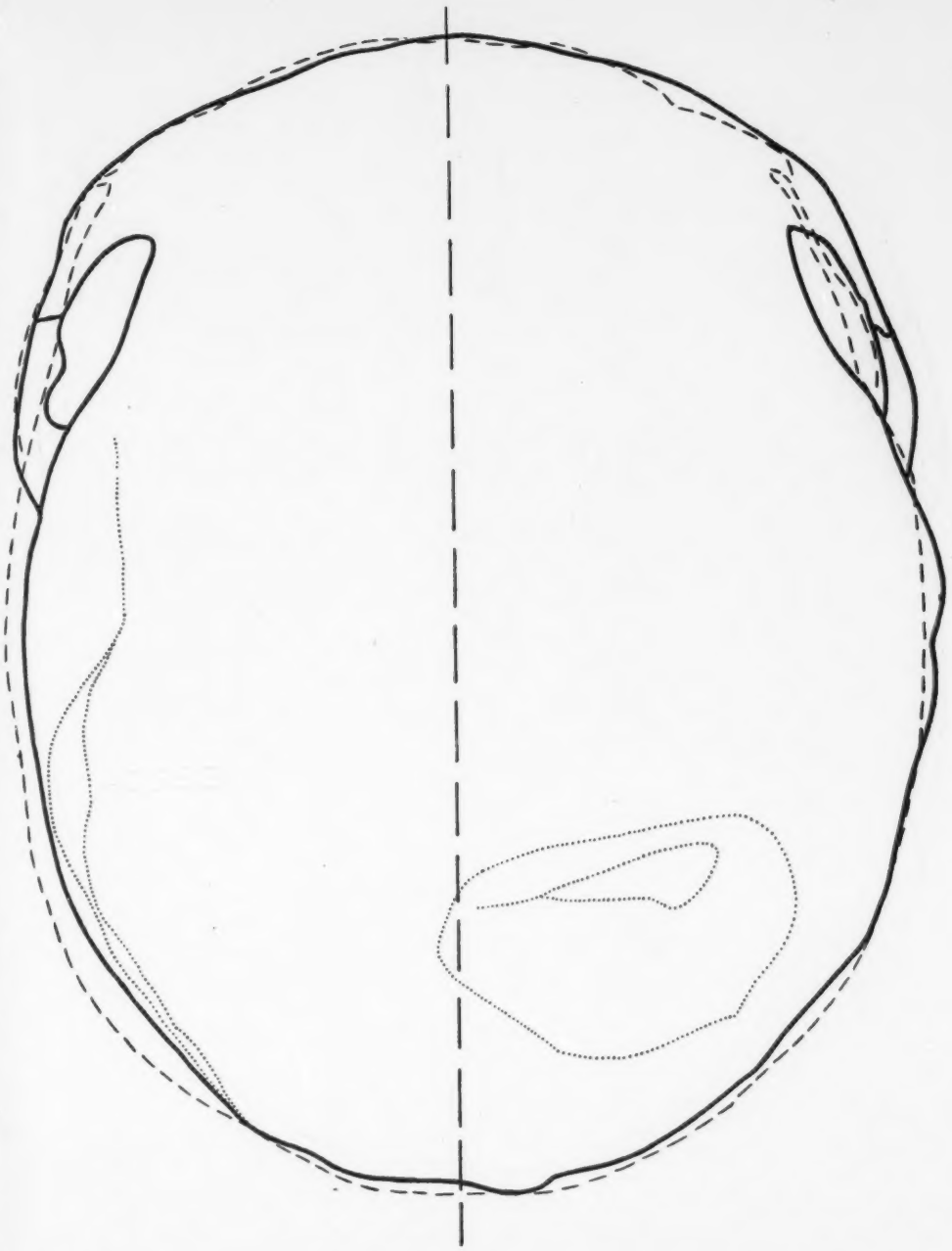


Fig. 4. Dioptrographic projection of skull of Saint Magnus (continuous line) superimposed upon dioptrographic projection of skull of native of Aberdeenshire, Scotland (broken line). Dotted line indicates injuries to skull of Saint Magnus. Orientated in Frankfort horizontal plane.

Norma verticalis.

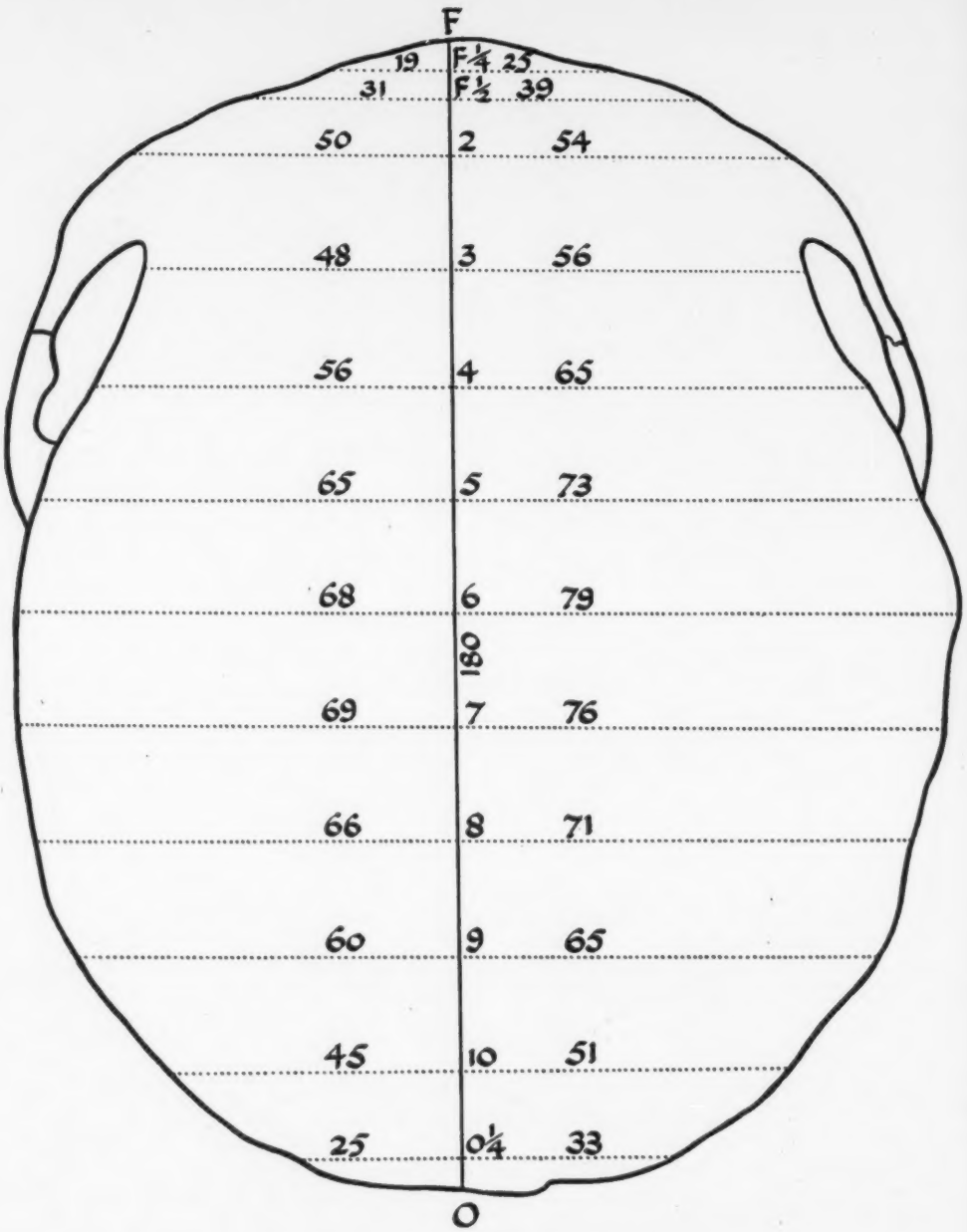


Fig. 5. Horizontal contour of the skull of Saint Magnus.

Dimensions in millimetres.

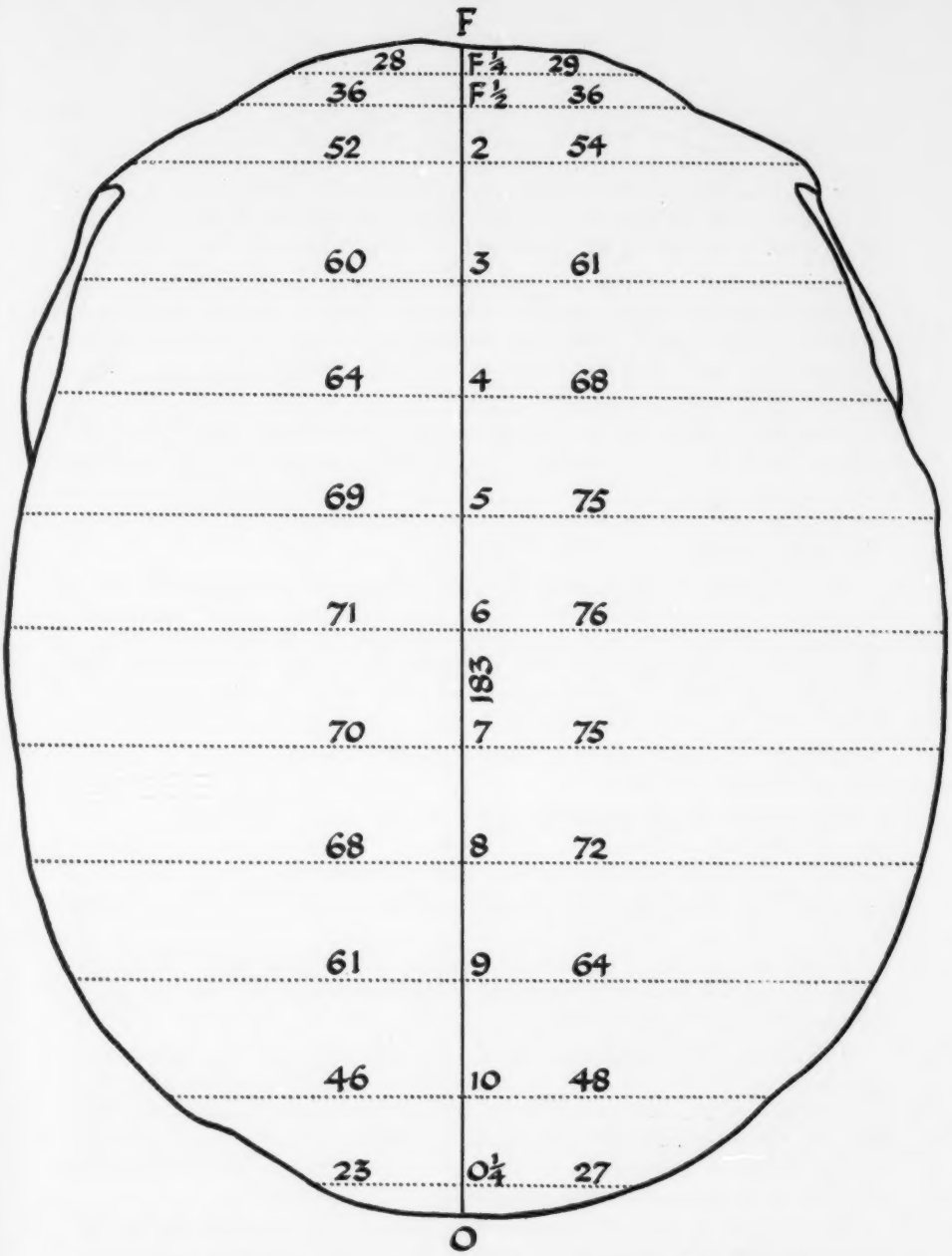


Fig. 6. Horizontal contour of the skull of a native of Aberdeenshire, Scotland.

Dimensions in millimetres.

exception of the sagittal which was closed in the neighbourhood of the obelion. Patches of post-mortem erosion were scattered over the surface of the skull.

On the right parietal bone above and behind the parietal eminence there was a smooth, broadly tongue-shaped area having its base directed anteriorly and its apex in the opposite direction. It measured 5·0 cm. from side to side and 3·5 cm. from before backwards. It exposed the diploë, and led at its base into the cavity of the cranium by an elongated aperture which measured 3·0 cm. from side to side and 1·0 cm. in its greatest measurement from before backwards.

This area had evidently been produced by a swift blow from a heavy sharp cutting instrument, which had first struck the cranium at right angles to its surface, and then passing downwards and backwards had removed a flake which involved both tables and the diploë anteriorly and thinned off so as to involve only the external table of the bone posteriorly.

Towards the back part of the left side of the norma was seen an elongated aperture which led into the cavity of the cranium and communicated anteriorly with a fissure which extended forwards as far as the lower part of the coronal suture. This aperture and fissure will be more fully described in connection with the norma lateralis.

Norma lateralis (Figs. 9, 10, 11, 12, Plate I, Figs. 7, 8). Looking at this aspect of the cranium it was noticeable that, as a whole, it was flattened from above downwards, this general impression being confirmed by the length-height index which on calculation was found to be 69·6. This index was lower than the corresponding index of 70·4 for the Aberdeenshire skull. It corresponded closely to the average index given by Turner for modern Scottish crania (16) and according to Martin's list of height indices of crania indicated a marked degree of general depression of the vault (14).

The alveolar process of the upper jaw had been removed along the line of the bases of the fangs of the teeth. The position of the alveolar point was thus left somewhat indefinite. The anterior nasal spine was prominent. The lower parts of the nasal bones were absent, but the profile of the nose was seen to be somewhat flattened.

Nasion and glabella were practically in the same vertical plane. The angle which this plane formed with the profile of the nose was wider than the corresponding angle in the Aberdeenshire skull.

The face was orthognathous. The alveolar index was approximately 90·2 as compared with the alveolar index of the Aberdeenshire skull which was 93·5. The frontal region of the skull was flattened towards the nasio-bregmatic line. The inion was very prominent. The interparietal part of the occipital bone was flattened, and the outline of the cerebellar fossa was but slightly curved. On both sides the temporal ridges were particularly apparent especially anteriorly.

Many patches of post-mortem erosion were visible on both sides of the skull. The parietal margins of the squamous portion of the temporal bones were particularly

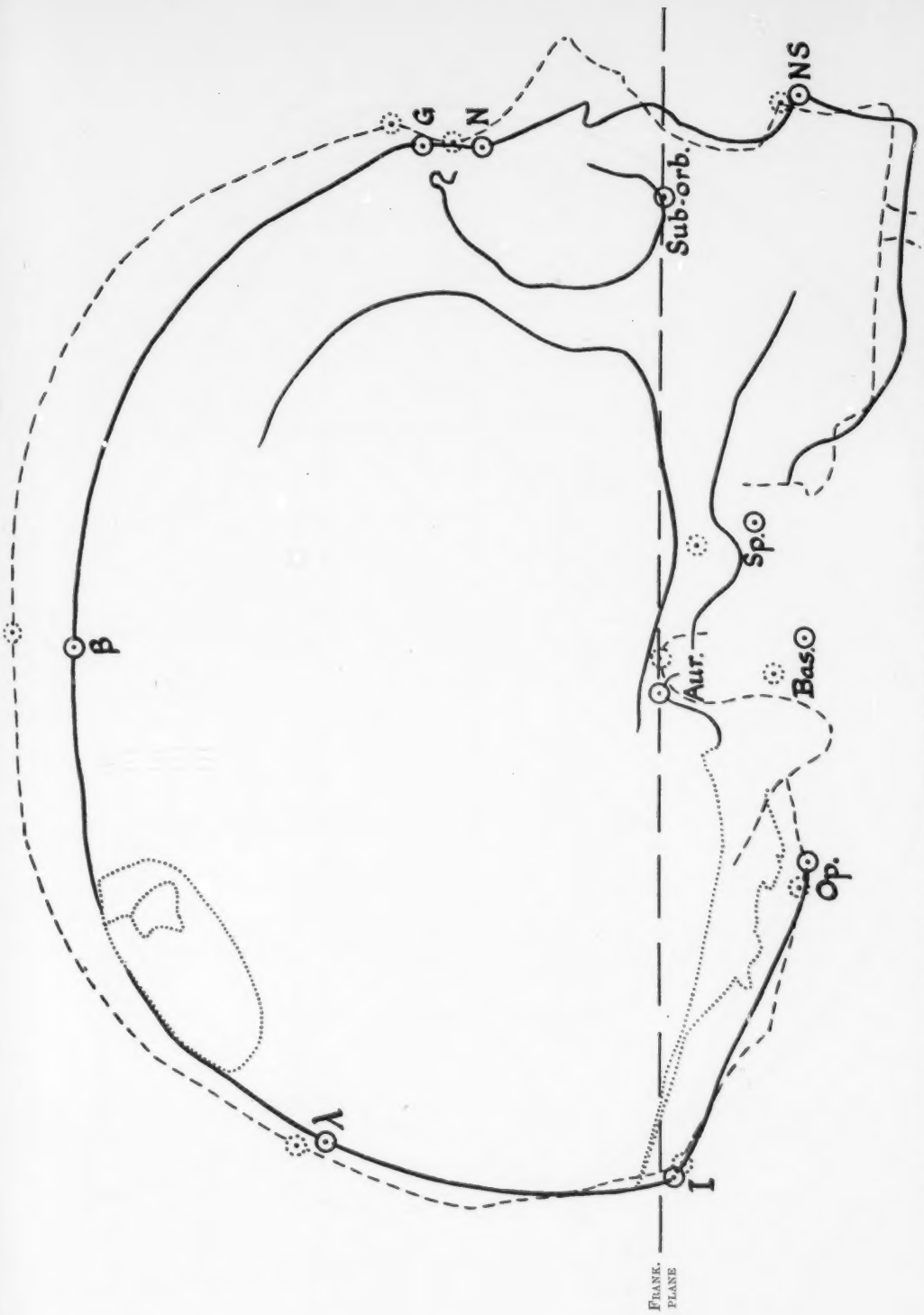


Fig. 9. Dioptrographic projection of skull of Saint Magnus (continuous line) superimposed upon dioptrographic projection of skull of native of Aberdeenshire, Scotland (broken line). Dotted line indicates injuries to skull of Saint Magnus. Orientated in Frankfort horizontal plane.
Norma lateralis (right profile).

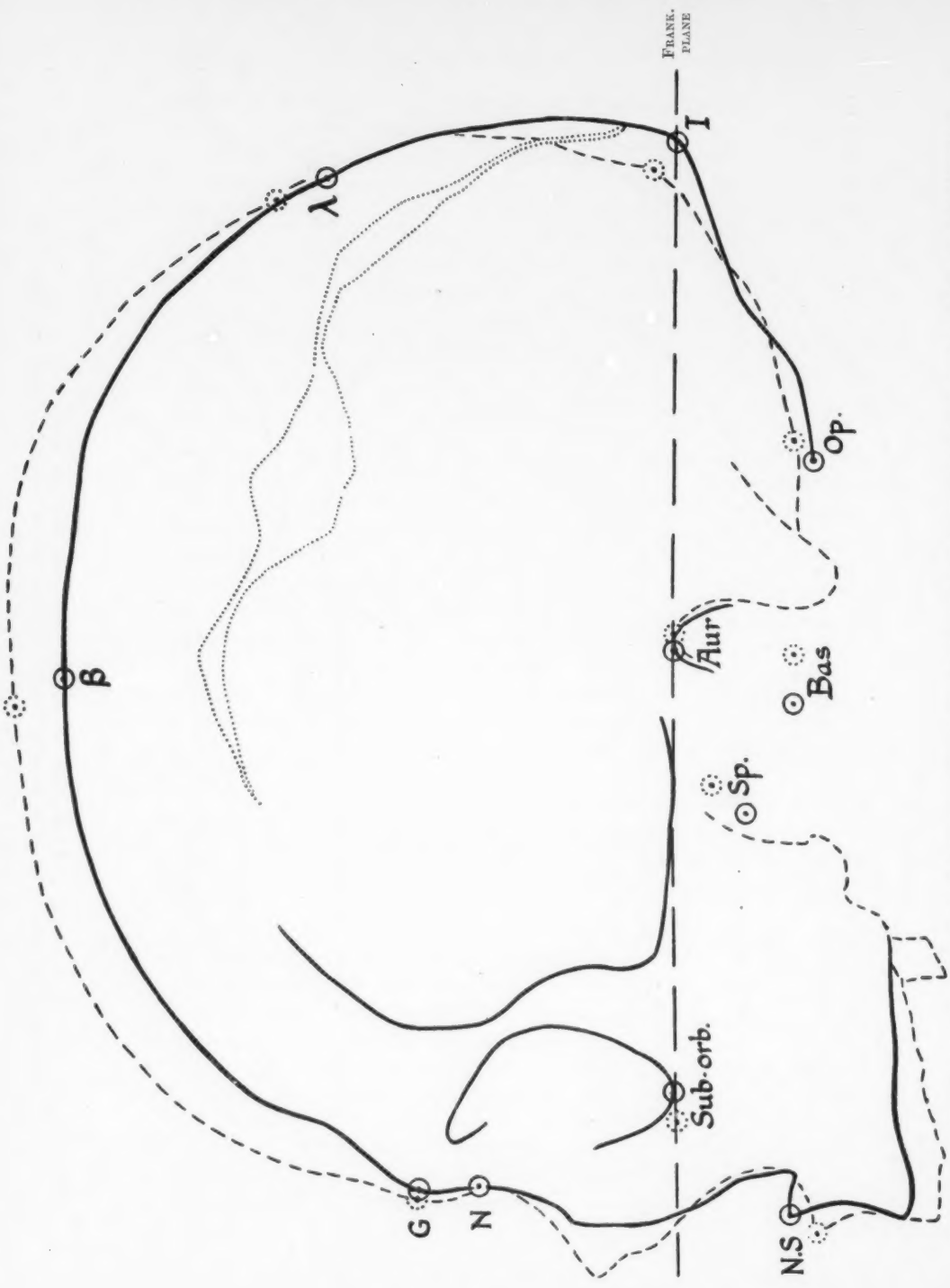


Fig. 10. Dioptrographic projection of skull of Saint Magnus (continuous line) superimposed upon dioptrographic projection of skull of native of Aberdeenshire, Scotland (broken line). Dotted line indicates injuries to skull of Saint Magnus. Orientated in Frankfort horizontal plane.
Norma lateralis (left profile).

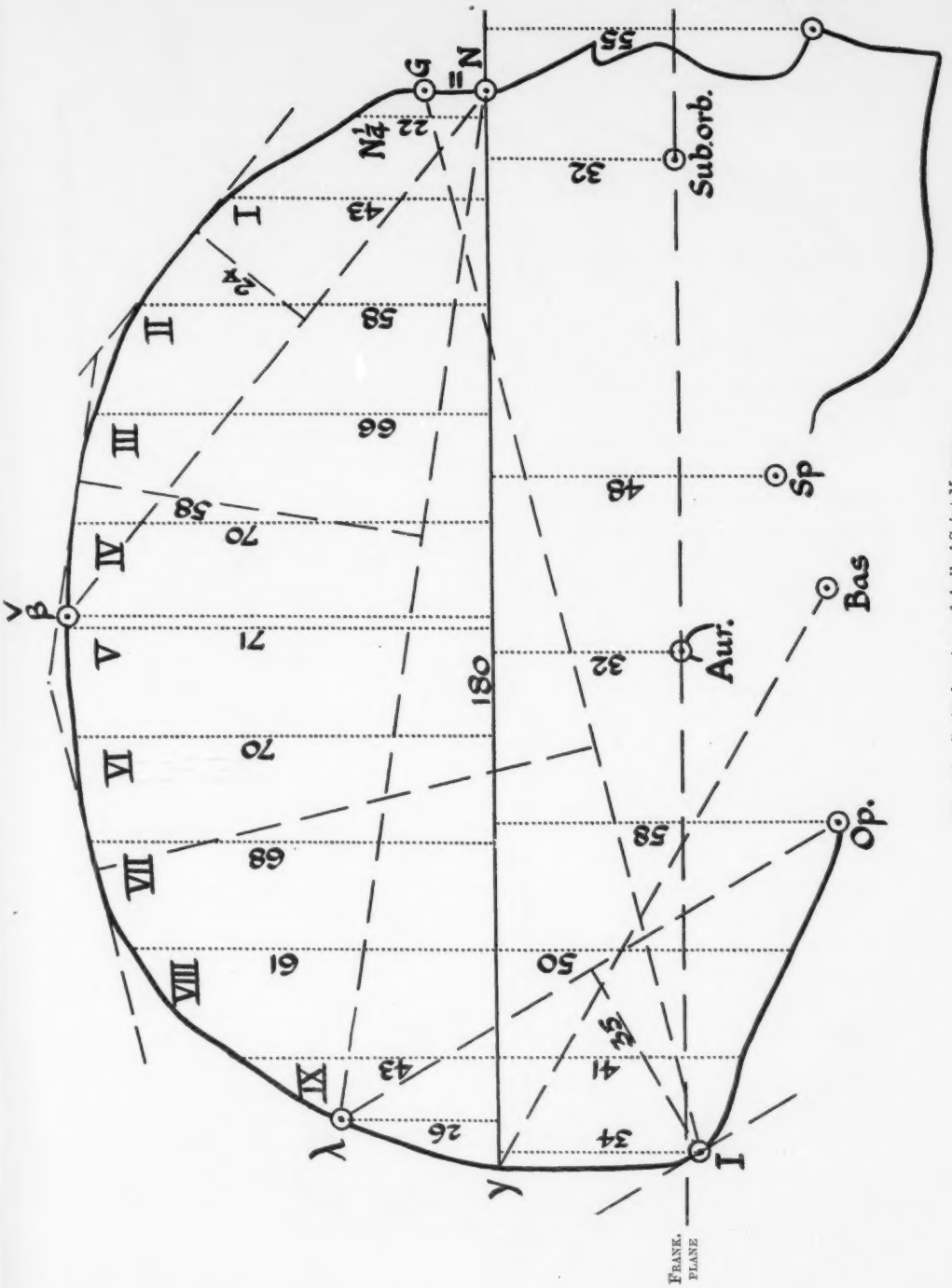


Fig. 11. Sagittal contour of skull of Saint Magnus.
Dimensions in millimetres.

Fig. 10. Diagrammatic [illegible]. Dotted line indicates injuries to skull of Saint Magnus. Orientated in Frankfort horizontal plane.
Scotland (broken line). *Norma lateralis* (left profile).

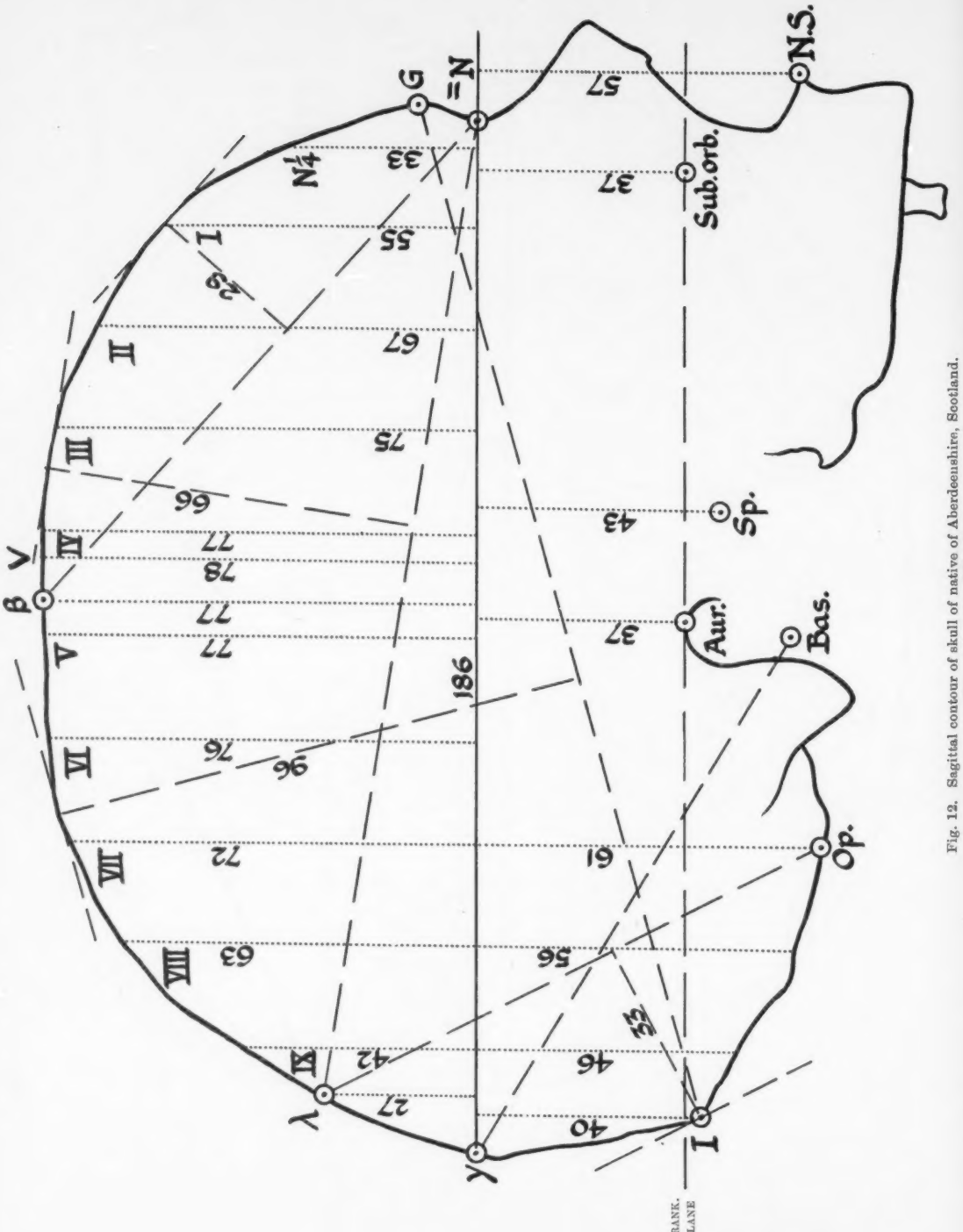


Fig. 12. Sagittal contour of skull of native of Aberdeenshire, Scotland. Dimensions in millimetres.

eroded in the same way. All the sutures visible on both normae laterales were open. Those in the region of the pterion were well marked and the spheno-parietal articulation measured 1·5 cm. in length.

The lateral aspect of the injury already described as seen on the vertex was visible on the right norma lateralis although very much fore-shortened in this aspect.

On viewing the norma lateralis on the left side a sinuous fissure was seen in the parietal and occipital bones extending backwards and downwards from a point in the coronal suture 4·0 cm. above the pterion, across the lambdoidal suture 3·0 cm. from the lambda, and passing through the right side of the occipital bone 1·5 cm. above the inion. This fissure became continuous with the cut surface to be described on the norma basalis. The fissure throughout its whole length communicated directly with the interior of the cranium and was widely open as it passed across the parietal eminence where its edges showed much post-mortem decay.

Norma occipitalis (Figs. 14, 15, 16, Plate III, Fig. 13). A conspicuous feature presented by this aspect was the relation of the height to the width of the cranium, for, as was shown by the breadth auricular-height index of 70·6—several points less than the average index 75·3 of Swiss skulls as given by Martin (14)—the skull was very much flattened from above downwards; this feature was well demonstrated by comparison with the Aberdeenshire skull whose breadth auricular-height index was 80·1 (Fig. 14).

The sutures were open with the exception of the sagittal which was closed in the posterior third of its length, and post-mortem erosions similar to those already mentioned were also visible in this view of the cranium.

The injuries already described in association with the vertical and lateral aspects of the skull were also seen in this view. The one descending from the left parietal region became continuous with a deficiency of the floor of the cerebellar fossa on the right side of the skull.

Norma basalis (Plate II, Fig. 17). All sutures were open with the exception of the occipito-sphenoid which was closed.

The widely spreading zygomatic arches were particularly well shown on this aspect, which also presented a series of three smoothly cut surfaces lying in different planes.

One had been produced by the removal of the inner part of the right eminentia articularis, the floor of the right middle cerebral fossa, the right styloid process, the right mastoid process, and the right half of the occipital bone as far as a point half an inch above the external occipital protuberance where it became continuous with the fissure already described as existing on the left side of the cranium.

Another had been produced by the removal of a portion of the floor of the left cerebellar fossa, the left mastoid process through its antrum, the lower part of the petrous portion of the temporal bone, and both condyles of the occipital bone.

Fig. 12. Sagittal contour of skull of native of Aberdeenshire, Scotland. Dimensions in millimetres.

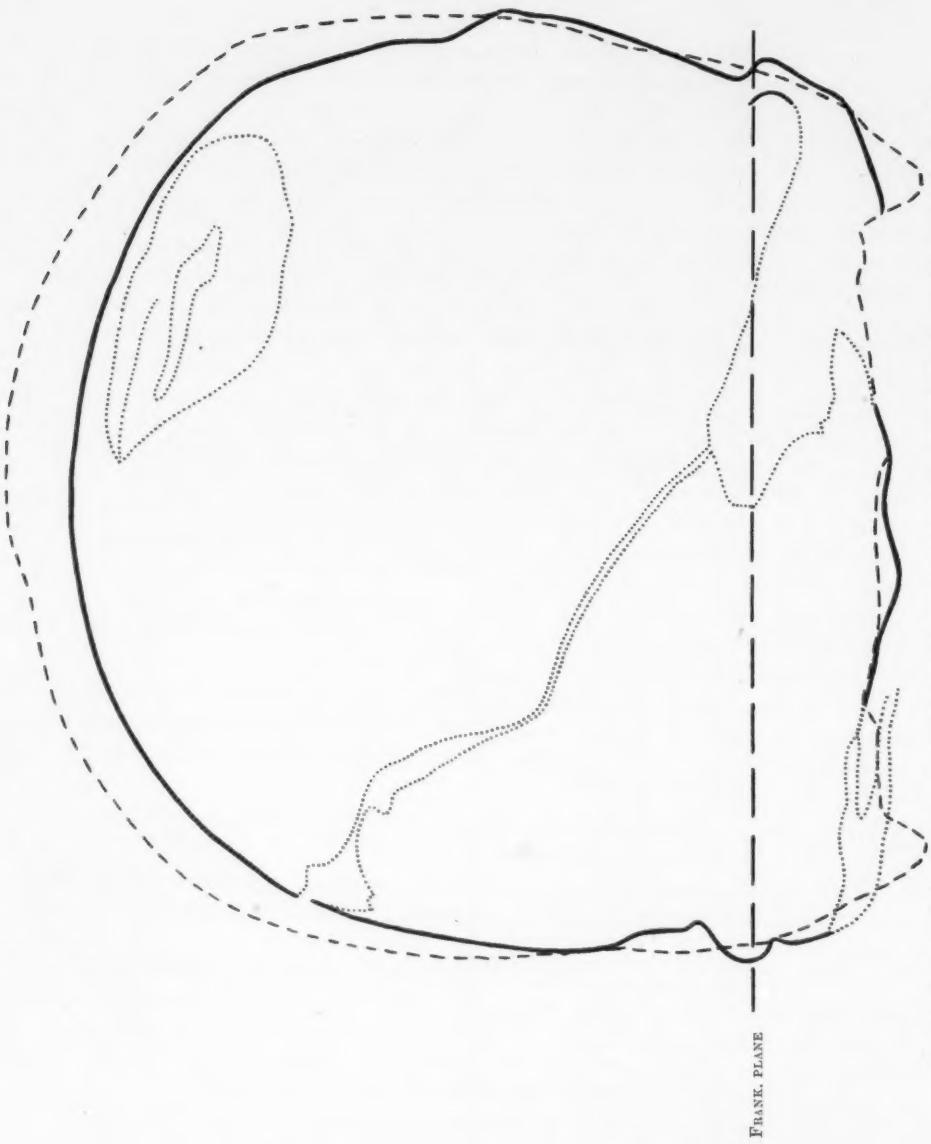


Fig. 14. Dioptrographic projection of skull of Saint Magnus (continuous line) superimposed upon dioptrographic projection of skull of native of Aberdeenshire, Scotland (broken line). Dotted line indicates injuries to skull of Saint Magnus. Orientated in Frankfort horizontal plane. *Norma occipitalis.*

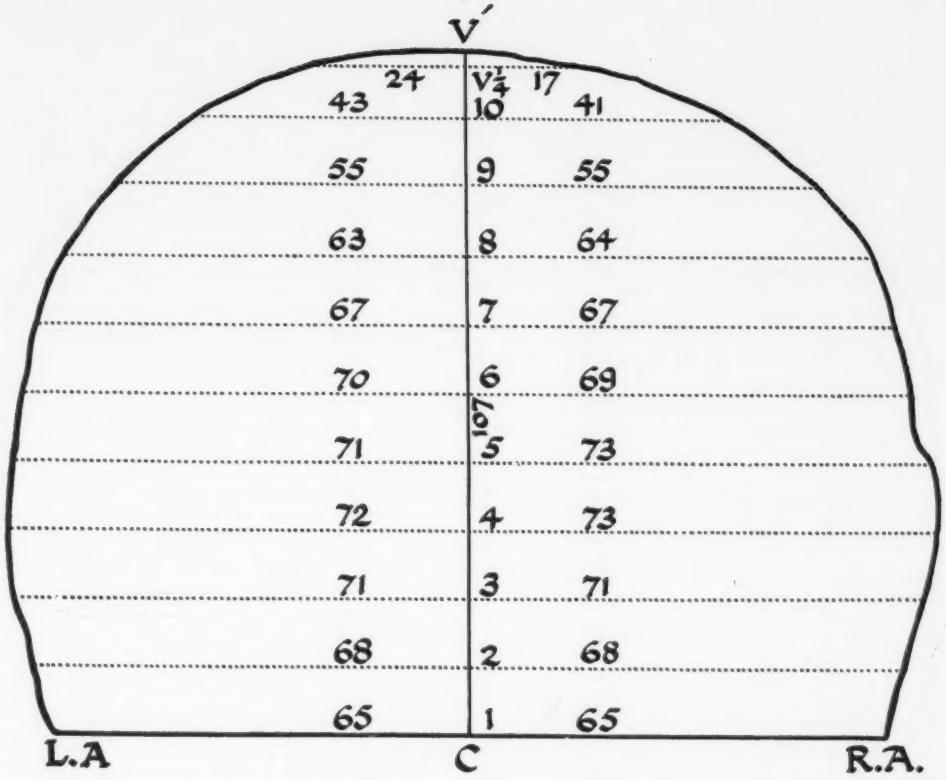


Fig. 15. Transverse vertical contour of the skull of St Magnus.

Dimensions in millimetres.

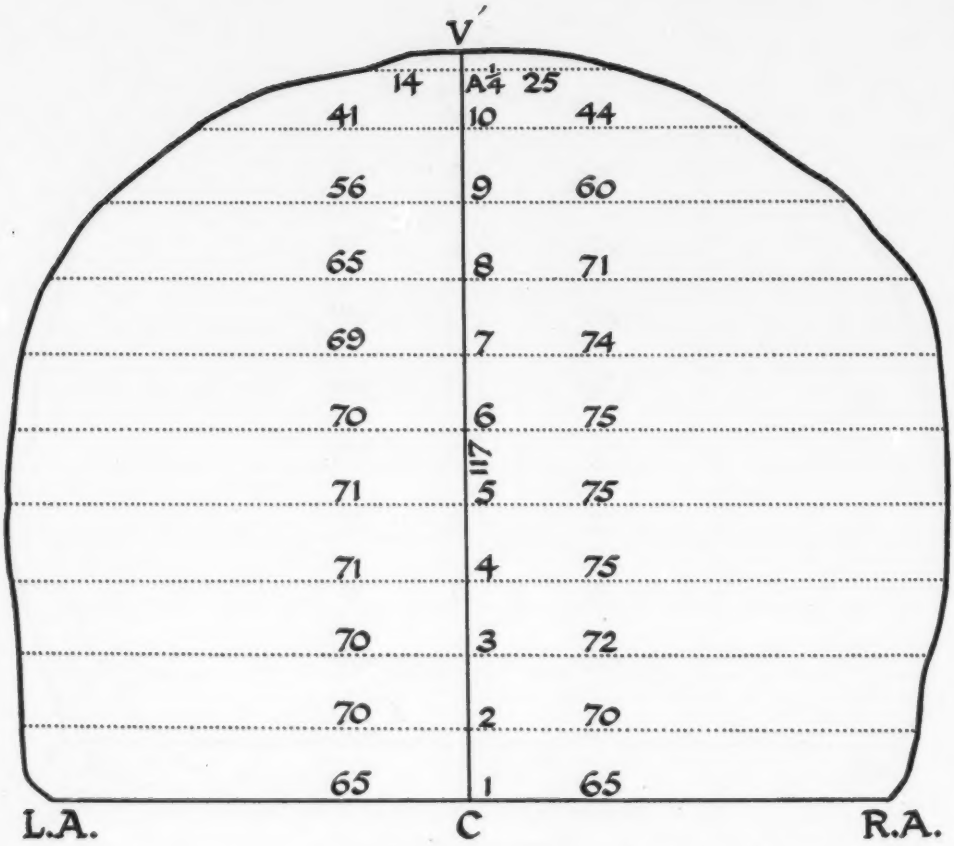


Fig. 16. Transverse vertical contour of the skull of a native of Aberdeenshire, Scotland.

Dimensions in millimetres.

A third had been made by the removal of the alveolar processes of both superior maxillary bones at the level of the junction of the necks of the teeth with their fangs. The plane of the last was not exactly flat, but presented a very slight uniform, antero-posterior hollow looking downwards.

The portions of all the teeth above the line of incision were present in their sockets in the alveolar processes with the exception of those of the second left bicuspid and the third right molar which had evidently fallen out after death. The cut surfaces of the teeth were exactly level with the cut surface of the surrounding bone in which they lay.

These three smoothly cut surfaces had evidently been produced by swift blows from some heavy sharp cutting instrument similar to that which had been used to produce the wound in the vertex. There was no appearance of a saw having been used to occasion these injuries.

The blow which caused the cut surfaces on the right side of the base had evidently given rise to the fracture described as seen on the left norma lateralis and on the norma basalis.

Norma facialis (Fig. 19, Plate III, Fig. 18). The flattening of the head from above downwards was again visible. The right frontal sinus was open as the result of post-mortem decay and showed that, although there was no very pronounced superciliary ridge, the frontal sinus was well developed. The zygomatic arches were prominent. The cut edge of the alveolar process was apparent.

The bridge of the nose was flattened and had a remarkably low simotic index of 34 as compared with the average 51 given by Ryley and Bell for the Whitechapel English skulls (15). The right nasal bone was broader than the left, so that the inter-nasal suture joined the fronto-nasal suture to the left of the middle line. The canine ridges upon the upper jaw, especially the right, were well marked.

As regards breadth the face occupied a position midway between the long and short varieties. Its upper face index was 52·8 as compared with 57·8 for the Aberdeenshire skull.

The orbits were mesoseme with an index of 86·4 and the nose was mesorhine with an index of 48·2 and was broad as compared with that of the narrow nosed Aberdeenshire skull with a nasal index of 44·2.

Vertebral column. The only part of the column which was present was the spine of a lumbar vertebra from the middle of the lumbar region.

Ribs. Six fragments of these bones were present—those of the left first rib, a last rib, and four shafts of ribs whose numbers could not be ascertained. The fragments of the first rib consisted of a part of the body, tubercle, and most of the neck, and although it was somewhat decayed its appearance suggested that its vascular and muscular markings had never been very distinct.

Clavicle. The acromial and greater part of the prismatic portion of the left clavicle existed but was slightly decayed. It was a slender bone with a very slight curvature. The greatest circumference of the prismatic part was 4·2 cm.

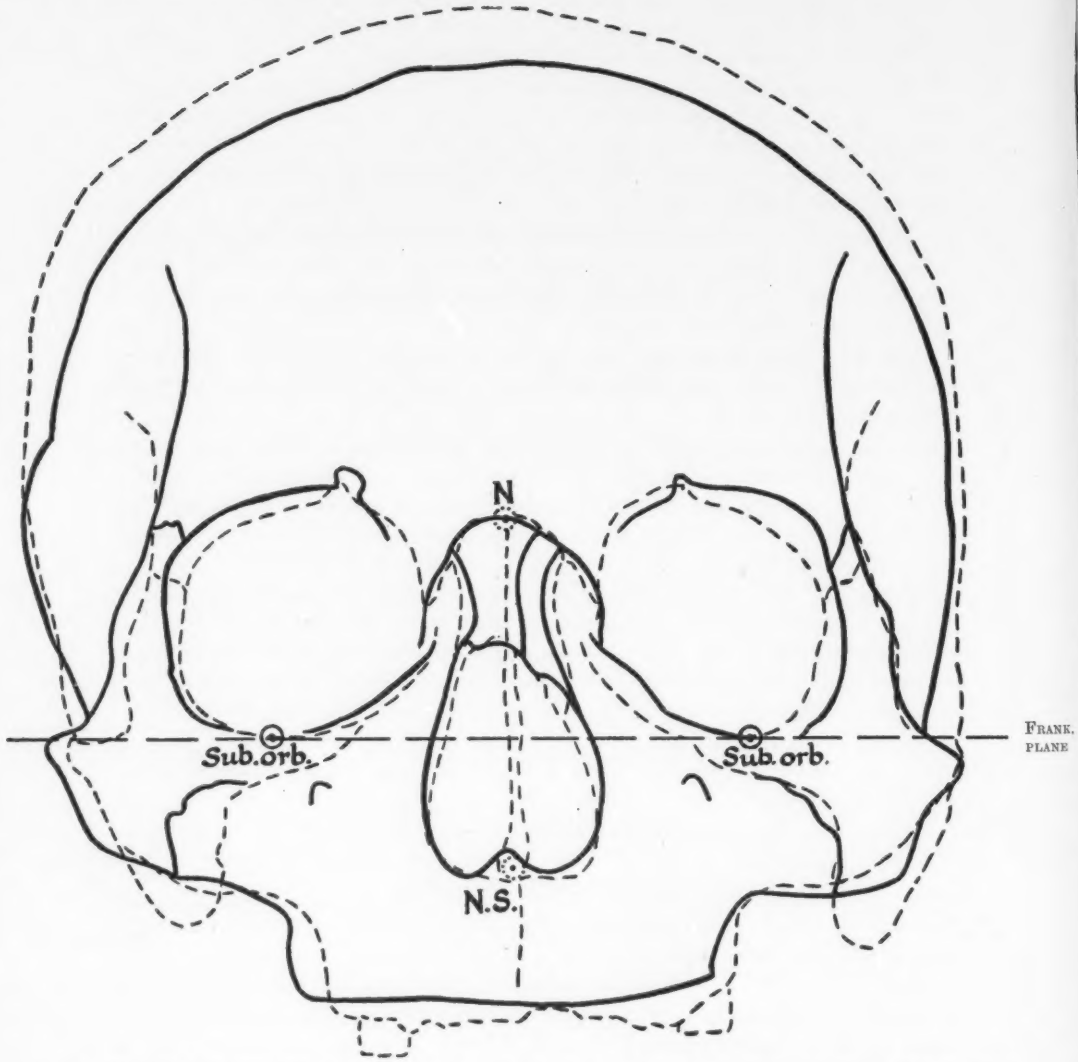


Fig. 19. Dioptrographic projection of skull of Saint Magnus (continuous line) superimposed on dioptrographic projection of skull of native of Aberdeenshire, Scotland (broken line). Orientated in Frankfort horizontal plane.

Norma facialis.

Scapula. The right was represented by a fragment consisting of the acromion process, coracoid process, glenoid cavity and upper third of the axillary border. The length-breadth index of the glenoid fossa was 70·3.

The fragment of the left scapula consisted of the acromion, posterior part of the spine and part of the neck.

In both scapulae the angle of the acromion was very evident and the areas for attachment of muscles and ligaments were well seen.

Humerus. In the right humerus the lower epiphyseal portion was wanting and the smallest circumference of the shaft below the deltoid eminence was 6·2 cm.

The lower extremity of the left humerus was absent, and the lower third of the shaft was much attenuated from decay.

The muscular markings, especially that for the deltoid muscle, were of normal size in each bone and in neither was a condyloid process or a coronoid foramen present.

Radius. Of the two radii the left one was entire. The curvatures of its shaft were conspicuous, especially in the region of insertion of the pronator radii teres muscle.

Its greatest length was 26·1 cm. Its physiological length, i.e., the distance between the deepest parts of the humeral and scaphoid articular surfaces, was 24·9 cm.

The smallest circumference below the middle of the shaft was 4·3 cm. The index of robusticity or length-girth index was 17·3 approximately.

The upper extremity with neck and tuberosity and immediately adjacent part of shaft of the right radius had disappeared from decay. The smallest circumference below the middle of the shaft, which was much eroded, was 3·7 cm. The curvatures in this bone were similar to those which were seen in the right.

Ulna. The left bone was present in its entirety. Its greatest length was 27·9 cm. Its physiological length, i.e., the distance between the deepest point of the greater sigmoid cavity and the deepest point of the articular surface on the head, was 24·9 cm. The smallest circumference of the shaft was 4·0 cm.

The index of robusticity or length-girth index was 16·1, and the curvatures of the shaft and muscular markings showed average appearances.

Hand. The only bones of the hand found among the remains were the base and part of the shaft of the third right metacarpal and portions of the shafts of two other metacarpals whose identity could not be ascertained.

Os innominatum. The right innominate bone was represented by a fragment composed of part of ilium, part of ischium, whole of pubis. The cotyloid cavity and margin of obturator foramen were intact. The greatest breadth of the cotyloid cavity was 5·4 cm. The edges of the depression at the bottom of this cavity and the cotyloid notch were very definitely defined.

The greatest breadth and greatest length of the obturator foramen were 3·7 cm. and 5·5 cm. respectively giving an index of 62·3 which practically corresponded with the average index—61·4—given by Martin for male Europeans (14).

A fragment consisting of part of the ilium and upper three-fourths of the cotyloid cavity was the only part of the left innominate bone preserved.

Femur. Both femora were complete with the exception of the great trochanters and the upper borders of the necks which had been destroyed by decay.

The oblique length, i.e., the distance between the highest point of the head and a plane tangential to the under surfaces of the condyles, was 47·2 cm. in the case of the right and 46·7 cm. in the case of the left bone.

The greatest length, i.e., the distance between the highest point of the head and the lowest point of the internal condyle, was 47·4 cm. in the case of the right and 47·1 cm. in the case of the left bone.

The platymeric index was 94·0 for the right and 75·8 for the left bone, which indicated that there was no undue flattening in the upper part of the shaft in the right bone, but that flattening showed itself very slightly in the corresponding region of the left bone.

Both the right and left bones gave a pilasteric index of 100.

The circumference in the middle of the shaft was 8·7 cm. in both cases which, when taken in conjunction with the total length of the bones, gave an index of robusticity or a length-girth index of 18·5 for the right and 18·6 for the left bone, indicating that the bones conformed in this respect with those of the average European.

Patella. The left patella was present but was much eroded along its edges. The articular surfaces, however, were intact. Its greatest length was 3·9 cm., its greatest breadth 3·0 cm. and its greatest thickness 1·9 cm.

Tibia. Both tibiae were complete. They were slender bones with muscular markings indistinct.

The greatest length, i.e., the distance between the tip of the spine and the tip of the internal malleolus, measured 39·6 cm. for the right and 39·4 cm. for the left bone.

The total length, i.e., the distance between the articular surface of the external tuberosity and the tip of the internal malleolus, measured 39·3 cm. for the right and 39·0 cm. for the left bone.

The smallest circumference of the shaft was 7·1 cm. in the case of both bones. The index of robusticity or length-girth index, i.e., the circumference of the shaft expressed as a percentage of its total length, was 18·1 for the right and 18·2 for the left bone.

As regards the degree of flattening of the shaft the platycnemic index in the case of the right bone was 72·5 and in the case of the left 66·7.

The retroversion angle of the right bone was 9° and of the left bone 8°. This indicated that neither tibial head was unduly turned backwards. The right tibia had a torsion angle of 12°·5, and the left of 12°.

The ratio of the total tibial to the total femoral length as expressed by the tibio-femoral index was 83·3 for the right and 83·6 for the left limb, indicating

that, in each case, the index was very slightly in excess of that associated with Europeans, which Turner gives as being below 83 (16).

Fibula. The head and upper inch of the shaft of the right fibula were absent. The remainder of the upper third of the shaft showed much post-mortem decay. The greatest thickness and smallest thickness of the mid-shaft were 1·4 cm. and 1·1 cm. respectively. The index of the transverse section of the mid-shaft, i.e., the smallest transverse thickness divided by the greatest thickness, was 78·6. The maximum circumference of the shaft was 4·3 cm.

The left fibula was complete but showed superficial erosion in the head and upper part of the shaft. The greatest length was 38·2 cm. The greatest thickness and smallest thickness of the mid-shaft were 1·4 cm. and 1·0 cm. respectively, which gave an index of the transverse section of the mid-shaft of 71·5. The maximum circumference of the shaft was 4·3 cm. and the smallest circumference of the bone below the head was 3·0 cm. The index of robusticity or length-girth index was 7·85.

Astragalus. Of the astragali the left alone was found among the remains, but it was well preserved.

Its length, i.e., the distance between the deepest part of the groove for musculus flexor hallucis longus and the most anterior part of the navicular articular surface, was 5·4 cm.

Its greatest length, i.e., the distance from the tip of the lateral tubercle of the groove for the musculus flexor hallucis longus to the most anterior part of the navicular articular surface, was 5·5 cm.

Its height, i.e., the perpendicular distance between the highest point of the inner lip of the trochlea and the horizontal plane upon which the bone rested in its normal position in the foot, was 3·4 cm.

Its breadth, i.e., the distance between the tip of the lateral process and medial side of the astragalus in the transverse plane and the superior trochlear surface, was 4·3 cm.

The antero-posterior length of the deepest part of the trochlea was 3·6 cm. and the length of the head and neck taken together was 1·9 cm.

The deviation angle of the neck, i.e., the angle between the sagittal axis of the trochlea and the longitudinal axis of the neck, was 15°, which lay between the average 11° and 17°·8, given respectively by Sewell and Volkov for Europeans (12).

The length-breadth index, i.e., the breadth of the astragalus expressed as a percentage of its total length, was 79·6, which appeared to be a normal figure for Europeans.

The neck-talus index, i.e., the length of the neck plus that of the head of the astragalus expressed as a percentage of the length, was 35·2, but statistics were lacking for the accurate determination of the significance of this index.

Os Calcis. The right os calcis was present and intact.

Of this bone, the greatest length, i.e., the distance between the perpendiculars dropped from the most projecting point of the great tuberosity and the highest point of the articular surface for the cuboid to the horizontal plane on which the bone rested when present in the living body in the erect posture, was 7·5 cm.

The middle breadth, i.e., the perpendicular distance between lines which passed through the most projecting points of the sustentaculum tali and the anterior extremity of the posterior facet for articulation with the talus and which were parallel to the axis of the bone, was 4·2 cm.

The length-breadth index was 56·0.

The height, i.e., the height of the deepest part of the groove upon the upper surface of the bone behind the posterior facet for articulation with the astragalus above the horizontal plane described in connection with the definition of the greatest length, was 4·2 cm.

The deviation angle of the posterior articular surface, i.e., the angle which the long axis of the posterior articular surface made with the long axis of the bone, was 50°, which corresponded closely with the angle given by Martin as the average for the Tyrolese (14).

Navicular. The right navicular was present and well preserved. It showed no abnormal features.

Cuneiforms. The right internal and the left external cuneiforms were also found and were normal.

Cuboid. The left cuboid was discovered and showed a facet for articulation with the scaphoid.

Metatarsals. There were five metatarsal bones present, viz., the right third and fourth and the left first, third and fifth. All were normal. The length of the first was 6·0 cm. and the greatest breadth of its shaft was 1·3 cm. The length-breadth index was 21·7.

Stature. The stature of the individual during life as calculated from the greatest length of the right femur and the total length of the right tibia according to Professor Pearson's formula (*f*) for dry bones (18) was 171·7 cm. (5 ft. 7½ in.), with a probable error of 2·03 cm. The stature, therefore, practically corresponded to the average of modern Norwegian males, i.e., 171·98 ± ·11 cm., or that of the average modern Swede, viz., 171·37 ± ·02 cm. (17).

Summary of the Description of the Human Skeletal Remains found in the South Pillar.

(1) The remains were those of a man whose age, roughly estimated, was from twenty-five to thirty-five years, whose stature was about 171·7 cm. (5 ft. 7½ in.), and who was rather poorly developed physically.

(2) His head as regards cephalic index was mesocephalic but tended towards the brachycephalic type.

(3) His cranial capacity (1380 c.c.) was much below (117 c.c.) that of the average (1497 c.c.) of the modern male European.

(4) He had a broad nose, prominent cheek bones, orbits like those of the average modern European, somewhat receding forehead and markedly flattened cranial vault.

(5) With the exception of incised wounds on the vault and base of the skull probably produced by swift blows from a heavy sharp cutting instrument which, if inflicted during life, must have resulted in his death, there were no other indications of injury or disease in his skeleton.

(6) He presented characters which were not purely of the type which we now associate with the taller element in the Scandinavian countries.

Remains found in the North Pillar.

The remains found in the north pillar consisted of portions of the skeleton of a man whose age was roughly estimated as from forty to fifty years and who was about 168·9 ± 2·03 cm. (5 ft. 6½ in.) in stature, of the lower jaw of an aged person, and of the metacarpal bone of a young pig. With the exception of a small splinter of pine wood none of the small fragments of wood previously mentioned as having been found were present.

The human skeletal remains were: skull (imperfect), mandible, fourth and fifth lumbar vertebrae (imperfect), sacrum (imperfect), shaft of rib (imperfect), right and left femora (imperfect), right and left tibiae, left fibula, astragalus, os calcis, second right (imperfect), fifth right, first left, second left, and fifth left metatarsal bones.

Skull (Fig. 21, Plate IV, Figs. 20, 22). The portions of the skull which were present were in a fairly good state of preservation.

The capacity of the cranium as estimated by the use of shot was 1530 c.c., which was above the average, 1497 c.c., of mixed Europeans as given by Flower (13), and as regards its shape it was mesaticephalic with a breadth index of 78·1.

Owing to absence of bones of the face it was impossible to orient the skull in the Frankfort plane and it was thus valueless to make tracings of any other norma than the lateralis.

As regards the face the only portions present were a detached fragment consisting of the right malar bone and the malar process of the right superior maxilla, also the upper parts of the nasal bones and nasal processes of the superior maxillae which were in articulation with the frontal bone. The latter fragments formed a well marked high nasal bridge with a simotic index of 60 approximately.

The superciliary ridges and glabella were moderately developed. The subtense to the nasio-bregmatic arc was 2·7 cm. This was 0·2 cm. less than that of the Aberdeenshire skull.

The length-height index was 69·4, being slightly less than 70·9 given by Turner as the average of Scottish skulls (16).

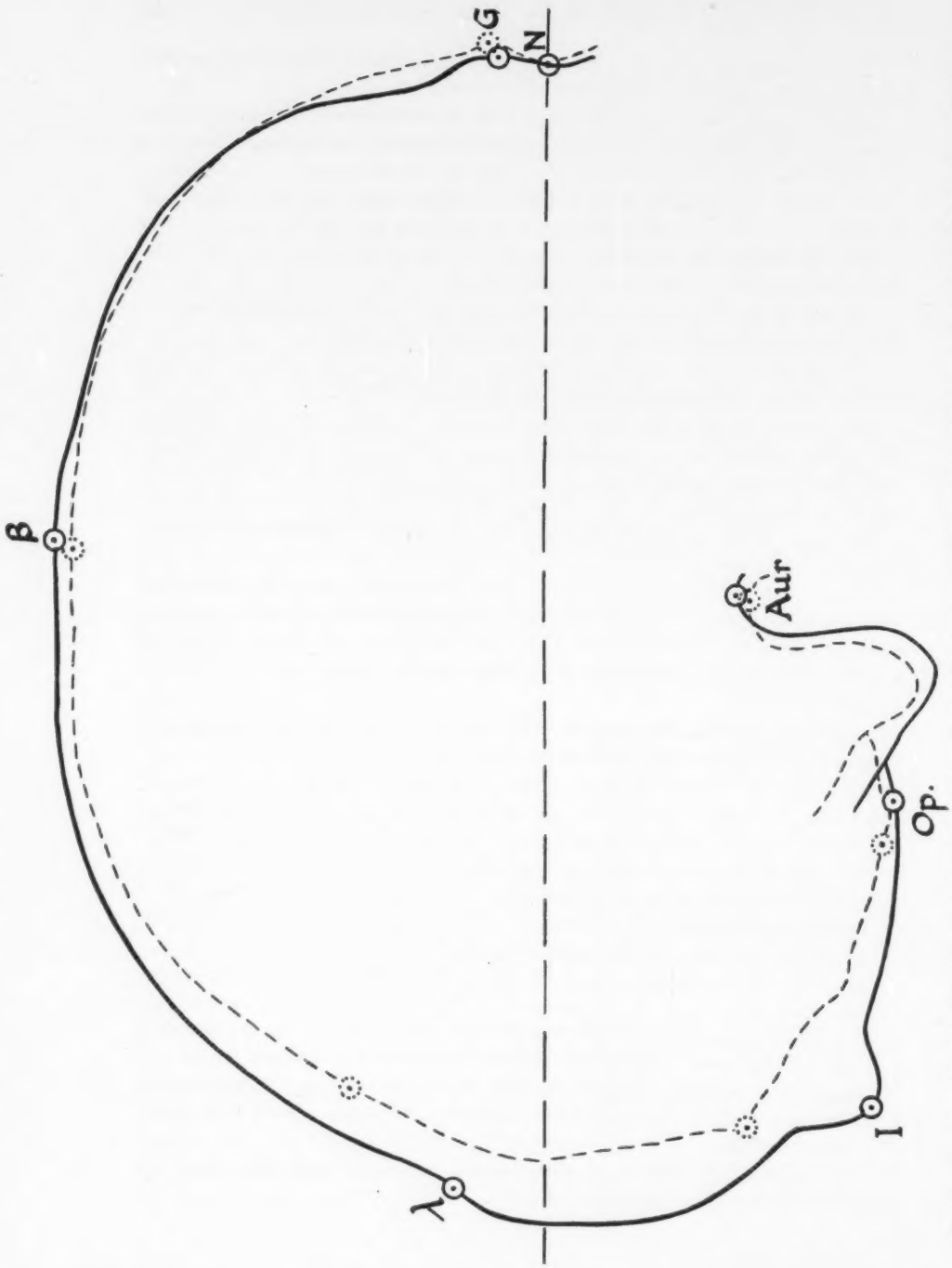


Fig. 21. Dioptrographic projection of skull of Saint Rognvald (continuous line) superimposed upon dioptrographic projection of skull of native of Aberdeenshire, Scotland (broken line). Orientated on line drawn from nasion to point most distant from nasion in median sagittal plane.
Norma lateralis (right profile).

In general outline the back of the skull was flattened, and showed a particular bulge in the occipital region especially at the inion.

The temporal ridges were pronounced and in their sweep upwards and backwards caused a marked narrowing of the forehead at the level of the ophryon.

All the cranial sutures were open with the exception of the sagittal in its whole length, the spheno-frontal, and the spheno-parietal. There was a well marked but smooth shallow depression behind the bregma in the position occupied by the hinder part of the anterior fontanelle in early childhood. It showed no appearance of having been produced by injury. There were many patches of erosion over the surface of the cranium, one of which was immediately above and parallel to the spheno-frontal suture.

A lower jaw was present with the remains in the north pillar, but it did not belong to this or to the skull found in the south pillar. Its intercondyloid exceeded the interglenoid measurement of the skull by 1 cm. It was the jaw of an old individual and was much attenuated and decayed along its angles and the posterior borders of its rami. All the teeth were absent, the alveolar process was almost completely absorbed, and the mental foramina were distant 1·5 cm. and 1·2 cm. from the upper and lower borders of the body of the bone respectively.

Vertebral column. The only parts of this column present were the complete fifth and part of the body of the fourth lumbar vertebra, and two fragments of sacrum one consisting of the bodies of the second, third, and fourth sacral vertebrae and the other of a fragment of the left sacral ala.

On the edges of the imperfect fourth lumbar vertebra there was marked appearances of the effects of rheumatism.

Ribs. A portion only of the body of one of the true ribs was present but it was impossible to identify its number.

Humerus. Both humeri were present, but their lower epiphyseal portions were absent. The muscular markings, especially the deltoidal eminences, were pronounced. No supracondyloid process or coronoid foramen was present in either bone. The smallest circumference of the shaft below the deltoid eminence was 7·4 cm. in the case of the right and 6·7 cm. in the case of the left bone. It was impossible to make the other usual measurements on account of the absence of the lower ends of the bones.

Femur. Both femora were present. The head, neck and great trochanter of the right femur were absent owing to decay. The great and small trochanters and upper border of the neck of the left bone were absent from the same cause. Connected with the small trochanter of the right femur, and the bone immediately surrounding it, was a spongy bony mass which had evidently been associated with the insertion of the ilio-psoas muscle. It was continuous below with the spiral line and the inner lip of the linea aspera, both of which were prominently marked. The area of insertion of the gluteus maximus muscle was also very evident. Signs of the effects of rheumatism were visible on the margins of the articular surfaces of the lower extremities of both bones.

Norma lateralis (right profile).

The oblique length of the left femur as measured from the highest point of the head to a plane which was placed so as to be a tangent to the under surfaces of the condyles was 46·2 cm.

The greatest length of the bone, i.e., the distance between the highest point of the head and the lowest point of the internal condyle, was 47·0 cm.

The circumference in the middle of the diaphysis was 10·3 cm. in the case of the right and 10·2 cm. in the case of the left bone. The index of robusticity, i.e., the circumference of the left diaphysis expressed as a percentage of its total length of the bone, was therefore 22·1.

The degree of flattening of the upper part of the left femur as measured by the platymeric index was 102·8. The pilasteric index was 109·7 for each bone.

These measurements and indices indicated that both femora corresponded in shape and size to that of the average European male of the present day.

Tibia. Both tibiae were complete. Origins and insertions of muscles were fairly well marked.

The greatest length, i.e., the distance between the tip of spine and tip of internal malleolus, measured 37·8 cm. in the case of the right and 38·1 cm. in that of the left bone.

The total length, i.e., the distance between the articular surface of the external tuberosity and the tip of the internal malleolus, of the right bone measured 37·2 cm. and 37·8 cm. in the case of the left bone.

The smallest circumference of the shaft was 8·3 cm. for the right and 8·2 cm. for the left.

The index of robusticity or the length-girth index, i.e., the circumference of the shaft expressed as a percentage of its total length, was 22·3 for the right and 21·7 for the left bone. The platycnemic index was 78·9 for both bones. The torsion angle was 36° for the right bone and 38°·5 for the left. The retroversion angle was 10°·5 in both cases. The tibio-femoral index for the left extremity was 81·8.

The only remark to be made about these measurements was that all corresponded to those found in the average European with the exception of the markedly forward and outward twisting of the inner part of lower ends of tibiae. No facet was seen on the anterior margin of the lower extremity of either tibia for articulating with the astragalus in extreme dorsiflexion of the joint.

Fibula. The left bone was present and its grooves, ridges and longitudinal curves were particularly worthy of notice as they indicated that powerful muscle had been attached to the bone.

Its greatest length was 36·2 cm. The greatest thickness and the smallest thickness of the mid-shaft were 1·7 cm. and 1·5 cm. respectively, giving an index of the transverse section of the mid-shaft of 88·3. The greatest circumference of the mid-shaft was 5·5 cm. and the smallest circumference of the shaft just below the head was

4·0 cm. The circumference of the bone in relation to its length as indicated by the index of robusticity or the length-girth index was 11·0.

Astragalus. Both astragali were present and in good condition.

The length, i.e., the distance between the deepest part of the groove for musculus flexor hallucis longus and the most anterior part of the navicular articular surface, was 5·7 cm. for both bones.

The greatest length, i.e., the distance from the tip of the lateral lip of the groove for the musculus flexor hallucis longus to the most anterior part of the navicular articular surface, was 6·2 cm. for each bone.

The breadth, i.e., the distance between the tip of the lateral process of the body and the medial side of the astragalus in a plane tangential to the trochlear surface, was 4·5 cm. for the right and 4·7 cm. for the left bone.

The height, i.e., the perpendicular distance between the highest point of the inner lip of the trochlea and the horizontal plane upon which the bone lay in its normal position in the foot, was 3·8 cm. for the right and 3·7 cm. for the left bone.

The antero-posterior length of the deepest part of the trochlea was 3·8 cm. for the right and 3·7 cm. for the left bone. The length of neck and head taken together was 2·2 cm. for each astragalus.

The deviation angle of the neck, i.e., the angle between the sagittal axis of the trochlea and the longitudinal axis of the neck, was 18° for the right and 19° for the left bone, corresponding closely with the average 17·8° given by Volkov for Europeans (14). No facets existed upon the upper or the lateral surface of the neck.

The length-breadth index for the right bone was 79·0 and for the left 82·5. The neck-talus index for the right bone was 38·6 and for the left 40·0.

Os calcis. Both bones were present and in good condition.

The greatest length, i.e., the distance between perpendiculars dropped from the most projecting point of the great tuberosity and highest point of articular surface for the cuboid to the horizontal plane on which the bone rested in the erect posture, was 8·4 cm. for each bone.

The middle breadth, i.e., the distance between perpendiculars directed backwards from the most projecting point of the sustentaculum tali and the most anterior extremity of the posterior facet for articulation with the talus to a plane drawn at right angles to the line of its total length, was 4·4 cm. for both the right and left bones.

The height, i.e., the distance between the deepest part of the groove upon the upper surface of the bone behind the posterior facet for articulation with the astragalus and the point where the bone most closely approached the ground in the standing position, was 4·5 cm. for the right and 4·9 cm. for the left bone.

The deviation angle of the long axis of the posterior articular surface to the long axis of the bone was 52° in the case of the right and 53° in the case of the left bone.

Metatarsals. As already noted the only metatarsal bones present were the first left, the second right and left, and the fifth right and left. All were normal.

The length of the first left was 6·2 cm. and the greatest breadth of its shaft was 1·3 cm. The length-breadth index was 21·0.

Stature. The stature of the individual during life as calculated from the greatest length of the left femur and the total length of the right tibia according to Professor Karl Pearson's formula (f) for dry bones (18) was 168·9 cm. (5 ft. 6½ in.), with a probable error of 2·03 cm. This stature therefore was not significantly different from that of the average modern Norwegian, viz. 171·98 ± ·11 cm., or that of the average modern Swede, viz. 171·37 ± ·01 cm. (17).

Summary of the Description of the Human Skeletal Remains found in the North Pillar.

(1) The remains were those of a well developed man whose age, roughly estimated, was from forty to fifty years and whose stature was about 168·9 cm. (5 ft. 6½ in.).

(2) The skull was, as regards cephalic index, between the long and short varieties.

(3) The cranial capacity was rather above that of the average modern male European.

(4) With the exception of slight effects of rheumatism in the spine and lower limbs the bones were otherwise healthy and showed no indication of their having met with any injury during life.

(5) The measurements indicated that the skeleton possessed physical characters which were not purely of the type which we now associate with the taller element in the Scandinavian countries.

Conclusions.

(1) The results obtained from an investigation of the human remains found in the south and north pillars of the Cathedral of Saint Magnus, Kirkwall, Orkney, conformed with the descriptions and histories of Saint Magnus and Saint Rognvald as obtained from the Orkneyinga Saga and other relative documents.

(2) The investigation on the whole confirmed the conclusion that the human remains which were contained in a wooden case in the south pillar belonged to Saint Magnus and that those which were found in a cavity in the north pillar belonged in all probability to Saint Rognvald.

(3) It was interesting to note that as regards racial characters neither of the remains of the two Saints possessed characters which were purely of the type we now associate with the tall Nordic type.

Fig. 7. The skull of Saint Magnus.
Norma lateralis (right profile) (circa $\frac{1}{2}$ linear).

Fig. 8. The skull of Saint Magnus.
Norma lateralis (left profile) (circa $\frac{1}{2}$ linear).

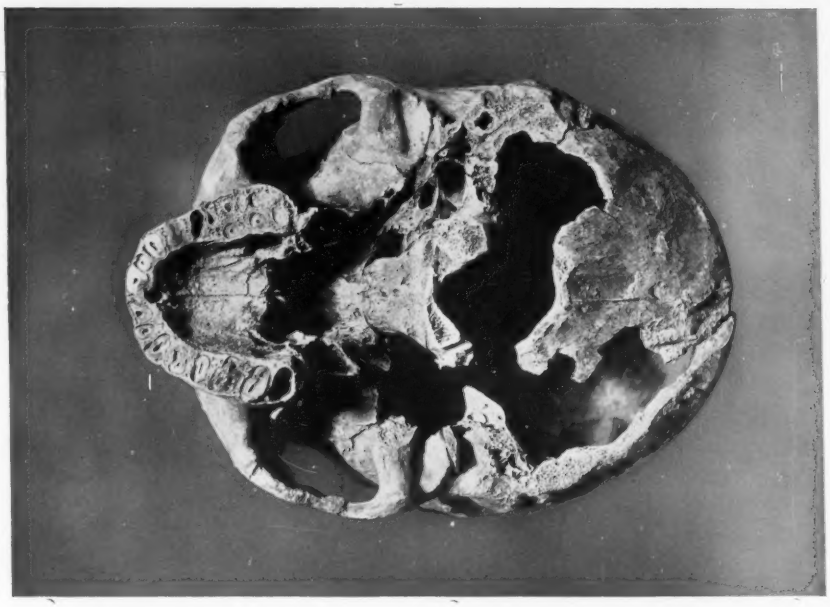


Fig. 17. The skull of Saint Magnus.
Norma basalis (circa $\frac{1}{2}$ linear).

Fig. 3. The skull of Saint Magnus.
Norma verticalis (circa $\frac{1}{2}$ linear).

Fig. 13. The skull of Saint Magnus.
Norma occipitalis (circa $\frac{1}{2}$ linear).

Fig. 18. The skull of Saint Magnus.
Norma facialis (circa $\frac{1}{2}$ linear).

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Fig. 22. The skull of Saint Rognvald.
Norma verticalis (circa ½ linear).

Fig. 20. The skull of Saint Rognvald.
Norma lateralis (right profile) (circa ½ linear).

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It was largely due to the kindness of the Rev. George Walker, D.D., Minister of the East Church of Saint Nicholas of Aberdeen, who entertains a hereditary veneration for the Cathedral, and who possesses a profound knowledge of the structure and history of that noble pile, that sanction was given to me by the Magistrates of Kirkwall, and the Trustees of the Bequest of the late Sheriff Thoms for the restoration of the Cathedral, to prosecute this research. My cordial thanks are due to Dr Walker for this and for the assistance which he gave me in the elucidation of the historical part of the research.

It is impossible to overestimate the help which I received from Dr Mulligan, my former Assistant and Carnegie Teaching Fellow in the Anatomy Department of the University of Aberdeen, in carrying out this work and I wish to acknowledge it most gratefully.

I am indebted to Miss I. E. Reid, M.B.E., for the sketch of the interior of the choir of the Cathedral showing the position in which the relics were found.

I wish to record my appreciation of the manner in which the Thoms' Trustees, the Magistrates and Town Council of Kirkwall, enabled me to obtain access to the relics. My thanks are due to the Rev. William Barclay, M.A., for allowing me to use the Vestry of the Cathedral in which to conduct the investigation.

I desire to record my warmest thanks to Professor Karl Pearson, F.R.S., for many valuable suggestions and much kindness in facilitating the publication of this paper.

Explanation of Abbreviations used in Figures.

Alv. = Alveolar point. Aur. = Auricular point. Bas. = Basion. C. = Mid-point of inter-auricular line. F. = Point immediately above glabella on horizontal contour. Frank. plane = Frankfort horizontal plane. G. = Glabella. I. = Inion. LA. = Left auricular point. N. = Nasion. NS. = Tip of anterior nasal spine. O. = Point immediately below lambda on horizontal contour. Op. = Opisthion. RA. = Right auricular point. Sp. = Mid-point of spheno-occipital junction. Sub. Orb. = Sub-orbital point. V. = Vertex of skull. V′. = Point on transverse vertical contour of skull vertically above C. β. = Bregma. λ. = Lambda. γ. = Gamma, i.e., the point on the surface of the occipital region of the skull in the median plane on the same horizontal level as the nasion with the skull in the Frankfort horizontal plane.

TABLE I.

Measurements in centimetres and indices of the skulls of Saint Magnus and Saint Rognvald.

Symbols of Characters	Characters	Saint Magnus	Saint Rognvald
F	Ophryo-occipital length	18·2	19·3
L	Glabello-occipital length	18·4	19·6
B	Maximum horizontal breadth on parietal bones ...	14·6	15·3
	Breadth index (100 $B \div L$)	79·3	78·1
B'	Least forehead breadth	10·1	9·3
H'	Basio-bregmatic height	12·8	13·6
	Height index (100 $H' \div L$)	69·6	69·4
H	Height from basion to point vertically above it (with skull adjusted to Frankfort horizontal plane) ...	12·7	—
	Height index derived from H (100 $H \div L$)	69·0	—
	Transverse vertical index (100 $H' \div B$)	87·7	88·9
OH	Auricular height	10·3	—
	Breadth auricular height index	70·6	—
	Auriculo-bregmatic height	10·3	11·5
LB	Basion to nasion	10·2	9·8
Q'	Transverse arc between auricular points through vertex of skull	29·0	33·2
S	Sagittal arc from nasion to opisthion	35·4	40·3
S_1	Sagittal arc from nasion to bregma	12·6	13·2
S_2	Sagittal arc from bregma to lambda	10·5	14·0
S_3	Sagittal arc from lambda to opisthion	12·3	13·1
S_3'	Chord from lambda to opisthion	9·7	10·0
U	Greatest circumference of cranium	51·7	55·4
PH	(?) Alveolar point to tip of anterior nasal spine ...	2·1	—
G'H	Nasion to (?) alveolar point	7·5	—
GB	Distance between lower ends of malo-maxillary sutures	10·0	—
	Upper face index derived from GB (100 $G'H \div GB$) ...	75·0	—
J	Zygomatic breadth	14·2	—
	Upper face index (100 $G'H \div J$)	52·8	—
NH, R	Nasion to lowest part of right nasal notch	5·7	—
NH, L	Nasion to lowest part of left nasal notch	5·5	—
NB	Greatest breadth of anterior nares	2·7	—
	Nasal index right (100 $NB \div NH, R$)	47·4	—
	Nasal index left (100 $NB \div NH, L$)	49·1	—
DS	Dacryal subtense	1·55	—
DC	Dacryal chord	2·60	—
	Mesodacryal index (100 $DS \div DC$)	60·0	—
DA	Dacryal arc	4·30	—
SC	Simotic chord, i.e., the minimum between the two naso-maxillary sutures	1·09	0·60
SS	Simotic subtense	0·37	0·36
	Simotic index (100 $SS \div SC$)	34·0	60·0
SA	Simotic arc	1·35	1·20
O_1R	Greatest width of right orbit	4·4	—
O_1L	Greatest width of left orbit	4·4	—
O_2R	Greatest height of right orbit	3·8	—
O_2L	Greatest height of left orbit	3·8	—
	Orbital index right (100 $O_2R \div O_1R$)	86·4	—
	Orbital index left (100 $O_2L \div O_1L$)	86·4	—
GL	Basion to (?) alveolar point	9·2	—
	Alveolar index (approximately)	90·2	—
fml	Antero-posterior length of foramen magnum	3·9	3·6
fmb	Greatest breadth of foramen magnum	—	3·2
C	Capacity taken with shot	1380 c.c.	1530 c.c.
	Capacity taken with mustard seed	1400 c.c.	1540 c.c.

TABLE II.

Measurements in centimetres, angles and indices of bones of extremities of Saint Magnus and Saint Rognvald.

Characters	Saint Magnus		Saint Rognvald	
	Right	Left	Right	Left
Radius:				
Greatest length	—	26·1	—	—
Physiological length	—	24·9	—	—
Smallest circumference of shaft	3·7	4·3	—	—
Index of robusticity	—	17·3	—	—
Ulna:				
Greatest length	—	27·9	—	—
Physiological length	—	24·9	—	—
Smallest circumference of shaft	—	4·0	—	—
Index of robusticity	—	16·1	—	—
Femur:				
Greatest length	47·4	47·1	—	47·0
Oblique length	47·2	46·7	—	46·2
Circumference of mid-shaft	8·7	8·7	10·3	10·2
Index of robusticity	18·5	18·6	—	22·1
Platymeric index	94·0	75·8	—	102·8
Pilasteric index	100·0	100·0	109·7	109·7
Tibia:				
Greatest length	39·6	39·4	37·8	38·1
Oblique length	39·3	39·0	37·2	37·8
Smallest circumference of shaft	7·1	7·1	8·3	8·2
Index of robusticity	18·1	18·2	22·3	21·7
Platycnemic index	72·5	66·7	78·9	78·9
Torsion angle	12°·5	12°·0	36°·0	38°·5
Retroversion angle	9°·0	8°·0	10°·5	10°·5
Tibio-femoral index	83·3	83·6	—	81·8
Fibula:				
Greatest length	—	38·2	—	36·2
Smallest circumference of shaft	—	3·0	—	4·0
Index of transverse section of mid-shaft	78·6	71·5	—	88·3
Index of robusticity	—	7·85	—	11·0
Astragalus:				
Length	—	5·4	5·7	5·7
Greatest length	—	5·5	6·2	6·2
Breadth	—	4·3	4·5	4·7
Length-breadth index	—	79·6	79·0	82·5
Height	—	3·4	3·8	3·7
Length of deepest part of trochlea	—	3·6	3·8	3·7
Length of head plus neck	—	1·9	2·2	2·2
Neck-talus index	—	35·2	38·6	40·0
Deviation angle of the neck	—	15°·0	18°·0	19°·0
Os calcis:				
Greatest length	7·5	—	8·4	8·4
Middle breadth	4·2	—	4·4	4·4
Length-breadth index	56·0	—	52·4	52·4
Height	4·2	—	4·5	4·9
Deviation angle of posterior articular surface	50°·0	—	52°·0	53°·0

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THE CORPUSCLE PROBLEM.

SECOND MEMOIR. CASE OF ELLIPSOIDAL CORPUSCLES.

By S. D. WICKSELL, *Lund.*

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1. In my previous paper (*Biometrika*, Vol. XVII. pp. 84—99) I treated the case of spherical corpuscles and formulated the problem as follows: In an opaque body there are suspended a large number of corpuscles of different sizes, the density of the corpuscles and their size-distribution being the same in all parts of the body. To express the distribution of the sizes of the corpuscles in terms of the distribution of the sizes of the contours of corpuscles found in a plane section by which the body is split in two.

Denoting by $F(r)$ the frequency function of the diameter r of the corpuscles in general (the function required); by $f(r)$ the frequency function of the diameters of those special corpuscles which are cut by the plane of intersection; by $\phi(x)$ the frequency function of the diameters x of the circular contours in the section plane (the observed function) and by r_0 the mean diameter of the corpuscles in general, I found the following fundamental relations:

$$rF(r) = r_0 f(r) \quad \ldots\ldots\ldots\

Actuarial Society in Copenhagen, in November 1923, in a lecture of which a short review appeared in the Danish journal, *Assurandören*, in December 1923. In the meantime, however, and unknown to me, a paper discussing the corpuscle problem was published by the Swedish geologist, Hagerman, in *Geologiska Föreningens i Stockholm Förhandlingar*, 1924. Hagerman had run across the problem quite independently, in connection with some technical questions in the investigation of granulary minerals, and without noticing that the same problem had already been receiving for more than ten years the attentions of the Swedish anatomists. He points out that in the materials investigated by the petrographists the corpuscles or grains are generally not spherical but rather of ellipsoidal form, and he gives an interesting and so far quite correct, but from a mathematical point of view rather primitive, discussion of the problem. For the mathematical aspects involved he refers to an appendix to his paper written by a young mathematician and treating the special case when the corpuscles are ellipsoids of revolution of constant form. As I have had occasion to show in a short notice published in the same geological journal, in December 1925, this mathematical treatment of the problem is, however, fundamentally incorrect. Its results are quite misleading even in the case of spherical corpuscles. As the papers referred to are written in Swedish I do not think it necessary here to enter into details of their contents and my criticism, but I wish to acknowledge that it is the paper of Hagerman and the interesting applications there suggested which have made it clear to me that a full mathematical discussion of the ellipsoidal corpuscle problem is urgently wanted. This is, indeed, the primary cause of my now taking the matter up again. As referred to in the last section of this paper it has appeared subsequently that in mineralogical researches the problem is not only to determine the number and size distribution of the corpuscles, but also to find their total surface. Thus I have devoted the last section of this paper to a discussion of this more special problem.

2. In treating of the ellipsoidal corpuscle problem, the first important question is to define what is to be meant by the *size* or *diameter* of an ellipsoidal corpuscle, and of the elliptic contour cut out of it by the section plane. As will be seen later on, several different definitions are possible, and in special cases the one or the other will be preferable from the point of view of mathematical simplicity. Thus, in cases where the corpuscles are prolate or oblate ellipsoids of revolution it will be most convenient to use the minor or major diameter, respectively, as size measures.

In the general case of tri-axial ellipsoids I have, however, found the geometric mean of the principal diameters the most suitable measure. Besides the relatively greater simplification of the mathematical expressions following from this choice of size measure, considerations of a more general nature also favour it. The geometrical mean of the principal diameters has the important property of giving a measure which is proportional to the cube root of the volume and the square root of the area, respectively, of the corpuscles or corpuscle contours in question. Generally speaking it seems most rational to define the size of a corpuscle by its

volume and the size of a section contour by its area, and when linear measures are wanted the diameter of the sphere or circle of equal volume or area will probably give the best measure.

3. I here put together some of the notations, definitions and relations used in the following discussion.

Section: an arbitrary plane section through the material containing the corpuscles.

Section Ellipse: the ellipse cut out of a corpuscle by the section. The principal diameters of the section ellipse are denoted by ξ_1 and ξ_2.

Central Ellipse: the ellipse cut out of a corpuscle by a plane through the centre and parallel to the section. The principal diameters of the central ellipse are denoted by σ_1 and σ_2.

The principal diameters of a corpuscle are denoted by s_1, s_2 and s_3, and by α_1, α_2 and α_3 we denote the direction cosines of the normal to the section with reference to the axes of the corpuscle. Denoting by h the "height" of a corpuscle, i.e. the distance between the two tangent planes, parallel to the section, it is easily found that we have

$$h^2 = s_1^2\alpha_1^2 + s_2^2\alpha_2^2 + s_3^2\alpha_3^2.$$

Hence, taking s_1 to be the major diameter, and denoting the two principal eccentricities by e_2 and e_3, we also have, since

$$\alpha_1^2 + \alpha_2^2 + \alpha_3^2 = 1,$$

the relation

$$h = s_1\sqrt{1 - \alpha_2^2 e_2^2 - \alpha_3^2 e_3^2} \quad \text{.....(3).}$$

As "diameter" of a corpuscle we take the geometric mean of its principal diameters. Thus the "diameter" of a given corpuscle is

$$\rho = \sqrt[3]{s_1 s_2 s_3}.$$

As "diameter" of the central ellipse, we take

$$r = \sqrt{\sigma_1 \sigma_2},$$

and as "diameter" of the section ellipse

$$x = \sqrt{\xi_1 \xi_2}.$$

Between the parameters h, ρ, r and x the following relations hold. By y is here denoted twice the distance of the centre of a corpuscle from the section plane. We then have, as can be easily verified,

$$\rho^3 = hr^2 \quad \text{.....(4),}$$

$$\frac{y}{h} = \frac{\sqrt{r^2 - x^2}}{r} \quad \text{.....(5).}$$

Further, since $s_2 = s_1\sqrt{1 - e_2^2}$; $s_3 = s_1\sqrt{1 - e_3^2}$, we have

$$\rho = s_1\left((1 - e_2^2)(1 - e_3^2)\right)^{\frac{1}{6}}.$$

We thus get

$$h = \rho \frac{(1 - e_2^2\alpha_2^2 - e_3^2\alpha_3^2)^{\frac{1}{2}}}{((1 - e_2^2)(1 - e_3^2))^{\frac{1}{6}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6),$$

and, according to (4),

$$r = \rho \frac{((1 - e_2^2)(1 - e_3^2))^{\frac{1}{12}}}{(1 - e_2^2\alpha_2^2 - e_3^2\alpha_3^2)^{\frac{1}{4}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7).$$

Finally we denote by

n the number of corpuscles to the unit area in the section,

$\phi(x)$ the relative frequency function of x for the corpuscles contained in the section,

$f(r)$ the relative frequency function of r for the same corpuscles,

N the number of corpuscles in general per unit volume of tissue,

$F(r)$ the relative frequency function of r for the corpuscles in general,

$P(\rho)$ the relative frequency function of ρ for the corpuscles in general,

$\Pi(\alpha_2, \alpha_3)$ the correlation function of α_2 and α_3, defining the way in which the principal axes of the corpuscles are directed,

h_r the regression of h on r for the corpuscles in general,

$M'(a)$ the arithmetic mean of any measure a in the corpuscles, contained in the section,

$M(a)$ the arithmetic mean of a for the corpuscles in general.

Here $\phi(x)$ is the observed, apparent distribution of the "diameters" and $P(\rho)$ is the distribution of the actual "diameters." The problem is to express $P(\rho)$ in terms of $\phi(x)$. This can be done in several ways, the most practical one, however, seems to be to express the moments of the function $P(\rho)$ in terms of the moments of the function $\phi(x)$, i.e. to express $M(\rho^t)$ in terms of $M'(x^s)$.

4. According to (5), and as already shown in § 7 of my previous paper, we must have

$$\phi(x) = x \int_x^R f(r) \frac{dr}{r\sqrt{r^2 - x^2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{I.}$$

This integral equation depends only on the assumption that the corpuscles have ellipsoidal form and are uniformly distributed in space. The equation is, in particular, independent of the way in which the corpuscles are orientated with regard to the direction of their axes (i.e. the form of the function $\Pi(\alpha_2, \alpha_3)$) and also of the way in which the eccentricities may vary.

5. In deducing the relations between $f(r)$ and $F(r)$ or $P(\rho)$ it is, however, necessary to make assumptions concerning the way in which the eccentricities and directions of the axes vary.

With respect to the former variation it is, indeed, very difficult to find any sufficiently general and at the same time simple law of distribution. That the variation of the eccentricities must be assumed to be independent of the direction parameters α_2 and α_3 is evident. But it seems indispensable also to assume it

independent of the size, as expressed by the "diameter" ρ. Otherwise there seems to be no way to solve the problem.

However, it will be possible to postpone the discussion of this question, which will not be prejudiced by our regarding for the present the eccentricities as constant, i.e. the corpuscles as having the same form.

Regarding the variation of the directions, I assume that it takes place in quite haphazard fashion, and quite independently of the sizes of the corpuscles. This implies the following: imagine a sphere of unit radius to be described around the centre of every corpuscle, and that the point in which the normal from the centre to the section plane intersects this sphere is marked off; imagine further that all those spheres are made to coincide, by referring them to the same centre, and rotating them, until the lines corresponding to the axes of the corpuscles coincide: then the points marked off will be uniformly distributed on the surface of this sphere. In other words, any direction of the normal, relative to the principal axes of the corpuscle, will be equally likely. Now, α_1, α_2 and α_3 are the rectangular coordinates of the point of intersection of the normal and the unit sphere. Hence the probability that α_2, α_3 falls within a given "element" of area" $d\alpha_2 d\alpha_3$ will be proportional to the element of surface on the sphere of which it is the projection. It is thus immediately seen that we must have

$$\Pi(\alpha_2, \alpha_3) = \frac{2}{\pi\sqrt{1-\alpha_2^2-\alpha_3^2}} \quad \text{.....(8).}$$

6. As the section will cut any corpuscle which has its centre within the distance $h/2$ on either side of the section plane, it is evident that we have

$$n = h_0 N,$$

h_0 being the mean value of the "heights" of the corpuscles. Furthermore, taking into consideration only corpuscles with a given central "diameter" r, it is as easily seen that we have

$$nf(r) = NF(r)\, h_r,$$

where h_r is the mean value of h for those corpuscles in which the central "diameter" is equal to r. Hence we have

$$f(r) = F(r)\frac{h_r}{h_0} \quad \text{.....II.}$$

This equation evidently corresponds to the relation (1), deduced for the case of spherical forms.

Now, as $$P(\rho)\,.\,\Pi(\alpha_2, \alpha_3)\, d\rho\, d\alpha_2 d\alpha_3$$

is the probability that a given corpuscle has the "diameter" ρ and the direction parameters α_2 and α_3, it is evident that we have

$$h_0 = \int_0^R d\rho \int_0^1 d\alpha_2 \int_0^{\sqrt{1-\alpha_2^2}} d\alpha_3 h\, P(\rho)\, \Pi(\alpha_2, \alpha_3) \quad \text{.....(9),}$$

where we may insert for h the expression (6). But if the integration is not, as above, extended to all possible combinations of the variables ρ, α_2 and α_3, but is

restricted to such combinations as give, when inserted in (7), an assigned value to r, we get, instead of h_0, the value of $F(r)\,h_r$ corresponding to that particular r. On account of II we have therefore

$$f(r)\,h_0 = \iiint h\; P(\rho)\,\Pi(\alpha_1, \alpha_2)\,d\rho\,d\alpha_2 d\alpha_3 \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{III},$$

the integration being extended over all values of the variables, which make

$$\rho\,((1-e_2^2)(1-e_3^2))^{\frac{1}{12}}\,.\,(1-e_2^2\alpha_2^2-e_3^2\alpha_3^2)^{-\frac{1}{4}}$$

equal to a given quantity r.

Equations I and III may be regarded as the fundamental equations of the ellipsoidal corpuscle problem. Solving I (in any one of the ways indicated in the previous paper) $f(r)$ is obtained; $f(r)$ being known $P(\rho)$ is determined by the integral equation III.

7. For solving III, I have found no better method than the method of moments. Multiplying both sides by r^s and integrating over all values of r we get, inserting on the right side the expressions (6) and (7) for h and r,

$$h_0 \int_0^R r^s f(r)\,dr = \int_0^R d\rho \int_0^1 d\alpha_2 \int_0^{\sqrt{1-\alpha_2^2}} d\alpha_3 \frac{((1-e_2^2)(1-e_3^2))^{\frac{s-2}{12}}\,\Pi(\alpha_2, \alpha_3)\,.\,\rho^{s+1}\,P(\rho)}{(1-e_2^2\alpha_2^2-e_3^2\alpha_3^2)^{\frac{s-2}{4}}}$$

$\ldots\ldots\ldots\ldots(10),$

or, using the notation explained in § 3,

$$h_0\,.\,M'(r^s) = M(\rho^{s+1})\,.\,M\left(\frac{((1-e_2^2)(1-e_3^2))^{\frac{s-2}{12}}}{(1-e_2^2\alpha_2^2-e_3^2\alpha_3^2)^{\frac{s-2}{4}}}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots(11).$$

This relation, in the form in which it stands, is independent of any other assumption than that α_2, α_3, e_2 and e_3 vary independently of ρ.

If now for the sake of convenience we write (11) in the form

$$h_0\,.\,M'(r^s) = M(\rho^{s+1})\,.\,\lambda_s \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(11\text{ bis}),$$

we have, using the expression (8) for $\Pi(\alpha_2, \alpha_3)$,

$$\lambda_s = [(1-e_2^2)(1-e_3^2)]^{\frac{s-2}{12}}\,\frac{2}{\pi}\int_0^1 d\alpha_2 \int_0^{\sqrt{1-\alpha_2^2}} d\alpha_3 \frac{(1-\alpha_2^2e_2^2-\alpha_3^2e_3^2)^{\frac{2-s}{4}}}{\sqrt{1-\alpha_2^2-\alpha_3^2}} \quad \ldots(12).$$

This integral is not in general an elementary function of e_2 and e_3. But as

$$\frac{2}{\pi}\int_0^1 d\alpha_2 \int_0^{\sqrt{1-\alpha_2^2}} d\alpha_3 \frac{\alpha_2^{2n}\,\alpha_3^{2m}}{\sqrt{1-\alpha_2^2-\alpha_3^2}} = \frac{(2m)!\,(2n)!\,(m+n)!}{(2m+2n+1)!\;m!\;n!},$$

λ_s may easily be obtained in the form of an expansion in powers of e_2 and e_3.

Performing the expansion in the usual manner, and putting

$$p_2 = e_2^2 + e_3^2,$$
$$p_4 = e_2^4 + \tfrac{2}{3}e_2^2e_3^2 + e_3^4,$$
$$p_6 = e_2^6 + \tfrac{3}{5}e_2^4e_3^2 + \tfrac{3}{5}e_2^2e_2^4 + e_3^6,$$
$$p_8 = e_2^8 + \tfrac{4}{7}e_2^6e_3^2 + \tfrac{18}{35}e_2^4e_3^4 + \tfrac{4}{7}e_2^2e_3^6 + e_3^8,$$

we obtain the following series:

$$\left.\begin{aligned}
\lambda_{-1} &= [(1-e_2^2)(1-e_3^2)]^{-\frac{1}{4}}\ [1-\tfrac{1}{4}\,p_2-\tfrac{3}{160}\,p_4-\tfrac{5}{896}\,p_6-\tfrac{5}{2048}\,p_8\cdots]\\
\lambda_0 &= [(1-e_2^2)(1-e_3^2)]^{-\frac{1}{6}}\ [1-\tfrac{1}{6}\,p_2-\tfrac{1}{40}\,p_4-\tfrac{1}{112}\,p_6-\tfrac{5}{1152}\,p_8\cdots]\\
\lambda_1 &= [(1-e_2^2)(1-e_3^2)]^{-\frac{1}{12}}\ [1-\tfrac{1}{12}\,p_2-\tfrac{3}{160}\,p_4-\tfrac{1}{128}\,p_6-\tfrac{77}{18432}\,p_8\cdots]\\
\lambda_2 &= 1\\
\lambda_3 &= [(1-e_2^2)(1-e_3^2)]^{\frac{1}{12}}\ [1+\tfrac{1}{12}\,p_2+\tfrac{1}{32}\,p_4+\tfrac{15}{896}\,p_6+\tfrac{65}{6144}\,p_8\cdots]\\
\lambda_4 &= [(1-e_2^2)(1-e_3^2)]^{\frac{1}{6}}\ [1+\tfrac{1}{6}\,p_2+\tfrac{3}{40}\,p_4+\tfrac{5}{112}\,p_6+\tfrac{35}{1152}\,p_8\cdots]
\end{aligned}\right\}\quad\ldots(13).$$

Since the exponent to the first factor and the coefficient of p_2 in the expansions are equal, the important fact comes out, that the deviation of λ_s from unity depends only on the fourth and higher powers of the eccentricities. Thus, expanding the first factor and multiplying, we find, putting

$$P_4 = e_2^4 - e_2^2\,e_3^2 + e_3^4,$$

the following expressions for the functions λ_s:

$$\left.\begin{aligned}
\lambda_{-1} &= 1+\tfrac{27}{360}\,P_4 + \text{terms of higher order}\\
\lambda_0 &= 1+\tfrac{16}{360}\,P_4 + \quad,, \quad ,,\\
\lambda_1 &= 1+\tfrac{7}{360}\,P_4 + \quad,, \quad ,,\\
\lambda_2 &= 1\\
\lambda_3 &= 1-\tfrac{5}{360}\,P_4 - \quad,, \quad ,,\\
\lambda_4 &= 1-\tfrac{8}{360}\,P_4 - \quad,, \quad ,,
\end{aligned}\right\}\quad\ldots\ldots\ldots\ldots\ldots(14).$$

It must be observed, however, that the series in (14) generally do not converge quite so rapidly as the series in (13).

8. In order to get an idea of the order of magnitude of the coefficients λ_s I have computed their values for the two special cases where $e_2 = e_3 = e$, and $e_2 = e$, $e_3 = 0$.

We have clearly, making the substitutions

$$\alpha_2 = \sin v \sin w,\ \alpha_3 = \cos v \sin w,$$

and

$$\alpha_2 = \cos w,\ \alpha_3 = \cos v \sin w,$$

respectively, the following two expressions for (12):

$$\lambda_s = [(1-e_2^2)(1-e_3^2)]^{\frac{s-2}{12}}\,\frac{2}{\pi}\int_0^{\frac{\pi}{2}}\int_0^{\frac{\pi}{2}} dv\,dw \sin w\,[1-e_2^2\sin^2 v\sin^2 w - e_3^2\cos^2 v\sin^2 w]^{\frac{2-s}{4}}$$

$\ldots\ldots\ldots(15),$

$$\lambda_s = [(1-e_2^2)(1-e_3^2)]^{\frac{s-2}{12}}\,\frac{2}{\pi}\int_0^{\frac{\pi}{2}}\int_0^{\frac{\pi}{2}} dv\,dw \sin w\,[1-e_2^2\cos^2 w - e_3^2\cos^2 v\sin^2 w]^{\frac{2-s}{4}}$$

$\ldots\ldots\ldots(15^*).$

Hence we have, for the case $e_2 = e_3 = e$,

$$\lambda_s = (1-e^2)^{\frac{s-2}{6}}\int_0^{\frac{\pi}{2}} dw \sin w\,[1-e^2\sin^2 w]^{\frac{2-s}{4}}\quad\ldots\ldots\ldots\ldots(16),$$

and, for the case $e_2 = e$, $e_3 = 0$,

$$\lambda_s = (1-e^2)^{\frac{s-2}{12}} \int_0^{\frac{\pi}{2}} dw \sin w \,[1 - e^2 \cos^2 w]^{\frac{2-s}{4}} \quad \ldots\ldots\ldots\ldots(16^*).$$

Case I. Prolate ellipsoids of revolution.

From (16) we get, putting

$$1 - e^2 \sin^2 w = \frac{1-e^2}{\cos^4 \phi},$$

$$\lambda_s = (1-e^2)^{\frac{8-s}{12}} \cdot \frac{\sqrt{2}}{e} \int_0^{\arccos \sqrt[4]{1-e^2}} \frac{d\phi}{\cos^{5-s}\phi \sqrt{1 - \frac{1}{2}\sin^2\phi}} = (1-e^2)^{\frac{8-s}{12}} \cdot \frac{\sqrt{2}}{e}\, y_{\frac{5-s}{2}}$$

$\ldots\ldots\ldots\ldots(17).$

When s is an even number, the integral reduces to an elementary form. We get after some reduction,

$$\left.\begin{aligned} \lambda_0 &= (1-e^2)^{-\frac{1}{3}} \frac{1}{2}\left[1 + \frac{1-e^2}{2e} \ln \frac{1+e}{1-e}\right] \\ \lambda_2 &= 1 \\ \lambda_4 &= (1-e^2)^{\frac{1}{3}} \frac{1}{2e} \ln \frac{1+e}{1-e} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots(17 \text{ bis}).$$

When s is an odd number the integral may be computed from a table of elliptic integrals. In Jahnke und Emde: *Funktionentafeln*, Teubner, 1909, the normal elliptic integrals

$$F(k, \phi) = \int_0^{\phi} \frac{d\phi}{\sqrt{1 - k^2 \sin^2 \phi}}, \quad E(k, \phi) = \int_0^{\phi} d\phi \sqrt{1 - k^2 \sin^2 \phi}$$

are tabulated to four decimal places. Putting

$$F = F(\sqrt{\tfrac{1}{2}}, \text{ arc cos } \sqrt[4]{1-e^2}), \quad E = E(\sqrt{\tfrac{1}{2}}, \text{ arc cos } \sqrt[4]{1-e^2}),$$

and reducing the integral y_r in the usual way (compare Serret-Scheffer: *Lehrbuch der Differential- und Integralrechnung*, Vol. II. Teubner, 1911), I find the following relations:

$$y_0 = F, \quad y_{-1} = 2E - F,$$

$$y_1 = \frac{2e}{\sqrt{2}}(1-e^2)^{-\frac{1}{4}} - y_{-1},$$

$$y_2 = \frac{1}{3}\left(\frac{2e}{\sqrt{2}}(1-e^2)^{-\frac{3}{4}} + y_0\right),$$

$$y_3 = \frac{1}{5}\left(\frac{2e}{\sqrt{2}}(1-e^2)^{-\frac{5}{4}} + 3y_1\right).$$

From these relations y_1, y_2 and y_3 are readily computed, and thus also λ_{-1}, λ_1 and λ_3.

The following table gives the values of λ_{-1}, λ_0, λ_1, λ_2, λ_3 and λ_4 to three decimal places.

TABLE I.

Values of the Coefficients λ_s to Three Decimal Places for $e_2 = e_3 = e$.

e	λ_{-1}	λ_0	λ_1	λ_2	λ_3	λ_4
0	1	1	1	1	1	1
0·1	1·000	1·000	1·000	1	1·000	1·000
0·2	1·000	1·000	1·000	1	1·000	1·000
0·3	1·001	1·000	1·000	1	1·000	1·000
0·4	1·002	1·001	1·001	1	1·000	0·999
0·5	1·007	1·004	1·002	1	0·999	0·998
0·6	1·016	1·009	1·004	1	0·997	0·996
0·7	1·036	1·021	1·009	1	0·994	0·990
0·8	1·067	1·050	1·021	1	0·985	0·977
0·9	1·249	1·140	1·058	1	0·962	0·941
0·95	1·537	1·291	1·118	1	0·926	0·888
0·99	2·967	1·943	1·345	1	0·811	0·720

Case II. Oblate ellipsoids of revolution.

From (16*) we get, putting

$$1 - e^2 \cos^2 w = \cos^4 w,$$

$$\lambda_s = (1-e^2)^{\frac{s-2}{12}} \frac{\sqrt{2}}{e} \int_0^{\text{arc cos } \sqrt[4]{1-e^2}} \frac{\cos^{5-s}\phi \, d\phi}{\sqrt{1 - \frac{1}{2}\sin^2\phi}} = (1-e^2)^{\frac{s-2}{12}} \frac{\sqrt{2}}{e} y'_{\frac{5-s}{2}} \quad \ldots(18).$$

When s is an even number the integral becomes, after some reduction, expressible in terms of the *arc sin* functions. I find

$$\left.\begin{aligned} \lambda_0 &= (1-e^2)^{\frac{1}{3}} \frac{1}{2}\left[1 + \frac{1}{e\sqrt{1-e^2}} \text{ arc sin } e\right] \\ \lambda_2 &= 1 \\ \lambda_4 &= (1-e^2)^{\frac{1}{6}} \frac{1}{e} \text{ arc sin } e \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots(18 \text{ bis}).$$

For odd values of s the integral may, in a manner similar to that used in *Case I*, be reduced to the two normal elliptic integrals F and E. I have found,

$$y_0' = F,$$

$$y_1' = 2E - F,$$

$$y_2' = \frac{1}{3}\left(\frac{2e}{\sqrt{2}}(1-e^2)^{\frac{1}{4}} + y_0'\right),$$

$$y_3' = \frac{1}{5}\left(\frac{2e}{\sqrt{2}}(1-e^2)^{\frac{3}{4}} + 3y_1'\right).$$

Taking E and F from the tables of Jahnke und Emde we compute y_1', y_2' and y_3', and thus also λ_{-1}, λ_1 and λ_3. The following table gives the values of λ_{-1}, λ_0, λ_1, λ_2, λ_3 and λ_4 to three decimal places.

TABLE II.

Values of the Coefficients λ_s to Three Decimal Places for $e_2 = e$, $e_3 = 0$.

e	λ_{-1}	λ_0	λ_1	λ_2	λ_3	λ_4
0	1	1	1	1	1	1
0·1	1·000	1·000	1·000	1	1·000	1·000
0·2	1·000	1·000	1·000	1	1·000	1·000
0·3	1·001	1·000	1·000	1	1·000	1·000
0·4	1·002	1·001	1·001	1	1·000	0·999
0·5	1·006	1·004	1·002	1	0·998	0·998
0·6	1·014	1·009	1·004	1	0·997	0·996
0·7	1·032	1·019	1·009	1	0·994	0·990
0·8	1·072	1·043	1·019	1	0·986	0·978
0·9	1·182	1·108	1·047	1	0·965	0·943
0·95	1·345	1·203	1·088	1	0·936	0·895
0·99	1·932	1·523	1·219	1	0·847	0·752

9. From equation I it follows, by multiplying both sides by x^s and integrating over all values of x from 0 to R (compare § 5 of the previous paper), that we have

$$M'(x^s) = k_s M'(r^s) \quad \text{.....(19),}$$

where k_s is a numerical factor given by the integral

$$k_s = \int_0^1 \frac{\xi^{s+1}\, d\xi}{\sqrt{1-\xi^2}} = \begin{cases} \dfrac{(s+1)!}{\left(\dfrac{s+1}{2}\right)!}\,\dfrac{\pi}{2^{s+2}} & \text{when } s \text{ is odd} \\ \dfrac{\left(\dfrac{s}{2}\right)!\, 2^s}{(s+1)!} & \text{when } s \text{ is even} \end{cases} \quad \text{.....(20).}$$

Hence, according to (11 bis), we have the relation

$$h_0 M'(x^s) = k_s \lambda_s M(\rho^{s+1}) \quad \text{.....(21).}$$

Now $M'(x^s)$ is the so-called sth moment (about the origin) of the "diameters" observed in the section. In my previous paper I denoted it by the symbol v_s'. Similarly $M(\rho^t)$ is the tth moment of the true "diameters" ρ. In my previous paper it was denoted by the symbol N_t'. And it was shown in § 5 of this previous paper that, when the corpuscles are spherical, we must have

$$N_1' v_s' = k_s N_{s+1}' \quad \text{.....(22).}$$

It is now seen, using the same notation here, that when the corpuscles are ellipsoids of constant form we have, instead of (22),

$$h_0 v_s' = k_s \lambda_s N_{s+1}' \quad \text{.....(23).}$$

Putting here $s = 0$ we get

$$h_0 = \lambda_0 N_1',$$

and we have, finally,

$$N_1' v_s' = k_s N_{s+1}' \frac{\lambda_s}{\lambda_0} \quad \text{.....(24).}$$

As we have $N_0' = 1$ we have, in particular,

$$N_1' = \frac{k_{-1}\lambda_{-1}}{v_{-1}'\lambda_0} \quad \text{.....(25),}$$

that is, N_1' is obtained from the harmonic mean of x. N_1' being found, any moment of the true distribution may be determined from the moments of the observed distribution by the aid of (20), (24) and (13), provided, of course, that the eccentricities are known.

We may now write $$N_{s+1}' = \frac{k_{-1}}{k_s}\frac{v_s'}{v_{-1}'}\frac{\lambda_{-1}}{\lambda_s}. \quad \text{.....(26).}$$

Denoting by N'' the moments of the distribution obtained, when any one of the methods of reduction, discussed in the previous paper (i.e. what may be called a "spherical reduction"), is applied to the observed section "diameters," we have from (22) the relation

$$N_{s+1}'' = \frac{k_{-1}}{k_s}\frac{v_s'}{v_{-1}} \quad \text{.....(27),}$$

and hence from (26), $N_s' = N_s''.\mu_s$, where $\mu_s = \dfrac{\lambda_{-1}}{\lambda_{s-1}}$ .....(28).

From the tables in § 8 we can now obtain the following tables for the coefficients μ_s for cases of ellipsoids of revolution.

These tables illustrate very well the fact that the eccentric form has no appreciable influence on the first five moments about the origin, when the eccentricity does not exceed 0·7, say. Although it is not, of course, mathematically stringent to draw the conclusion that if the first five moments of the true distribution and the "spherically reduced" observed distribution are practically identical, the two distributions are also identical, yet I think that—considering the nature of the problem under discussion—this conclusion may be drawn here without serious risk of error.

TABLE III.

Values of the Coefficients $\mu_s = \dfrac{\lambda_{-1}}{\lambda_{s-1}}$ *to Three Decimal Places for* $e_2 = e_3 = e$.

e	μ_1	μ_2	μ_3	μ_4	μ_5
0	1	1	1	1	1
0·1	1·000	1·000	1·000	1·000	1·000
0·2	1·000	1·000	1·000	1·000	1·000
0·3	1·001	1·001	1·001	1·001	1·001
0·4	1·001	1·001	1·002	1·002	1·003
0·5	1·003	1·005	1·007	1·008	1·009
0·6	1·007	1·012	1·016	1·019	1·020
0·7	1 015	1·027	1·036	1·042	1·046
0·8	1·035	1·045	1·067	1·084	1·092
0·9	1·096	1·180	1·249	1·298	1·327
0·95	1·191	1·375	1·537	1·660	1·731
0·99	1·532	2·213	2·967	3·669	4·133

TABLE IV.

Values of the Coefficients $\mu_s = \frac{\lambda_{-1}}{\lambda_{s-1}}$ *to Three Decimal Places for* $e_2 = e$, $e_3 = 0$.

e	μ_1	μ_2	μ_3	μ_4	μ_5
0	1	1	1	1	1
0·1	1·000	1·000	1·000	1·000	1·000
0·2	1·000	1·000	1·000	1·000	1·000
0·3	1·001	1·001	1·001	1·001	1.001
0·4	1·001	1·001	1·002	1·002	1·003
0·5	1·002	1·004	1·006	1·007	1 008
0·6	1·006	1·010	1·014	1·017	1·019
0·7	1·013	1·024	1·032	1·038	1·042
0·8	1·028	1·052	1·072	1·087	1·097
0·9	1·067	1·128	1·182	1·225	1·253
0·95	1·118	1·234	1·345	1·437	1·503
0·99	1·269	1·585	1·932	2·281	2·571

In order to get a standard of comparison for judging the effect of the factors μ_s, that is the factors by which we must multiply the "spherical moments" in order to obtain the actual moments of the true "diameters" ρ, I proceed in the following way.

It is well known that the standard deviations of the moments about the origin are obtained from the following formula:

$$\Sigma^2(N_s') = \frac{N_{2s}' - N_s'^2}{n},$$

where $\Sigma(N_s')$ is the standard deviation of N_s' in samples of n, and the moments are supposed to be determined in the usual way, as the means of the corresponding powers of the variates. Assuming now that the distribution is of the special type xe^{-x^2}, considered in the previous paper, § 6, the ratio $N_{2s}'/N_s'^2$ will be a given numerical constant, and we find

$$\frac{\Sigma(N_1')}{N_1'} = \sqrt{\frac{0{\cdot}27}{n}}; \quad \frac{\Sigma(N_2')}{N_2'} = \sqrt{\frac{1}{n}}; \quad \frac{\Sigma(N_3')}{N_3'} = \sqrt{\frac{2{\cdot}40}{n}};$$

$$\frac{\Sigma(N_4')}{N_4'} = \sqrt{\frac{5}{n}}; \quad \frac{\Sigma(N_5')}{N_5'} = \sqrt{\frac{9{\cdot}83}{n}}.$$

Table V, p. 154, shows the rates by which the moments are affected by the standard deviations in samples of $n = 4000$, 1000 and 250.

Comparing Table V with Tables III and IV we see that, when reducing the observations by the spherical method, we obtain a distribution with moments which, when the corpuscles are ellipsoidal with the eccentricities as great as 0·7, or so, although differing systematically, will not differ from the moments of the actual distribution by amounts greater than the standard deviation to be expected in samples of 4000.

TABLE V.

n	$1+\frac{\Sigma(N_1')}{N_1'}$	$1+\frac{\Sigma(N_2')}{N_2'}$	$1+\frac{\Sigma(N_3')}{N_3'}$	$1+\frac{\Sigma(N_4')}{N_4'}$	$1+\frac{\Sigma(N_5')}{N_5'}$
4000	1·01	1·02	1·03	1·05	1·05
1000	1·02	1·03	1·05	1·07	1·10
250	1·03	1·06	1·10	1·14	1·20

But even when the eccentricities are greater, if not extremely so, the spherical reduction of the section observations will give a fair approximation to the actual distribution of the "diameters" ρ. For eccentricities of the magnitude 0·8 the approximation may be compared to the errors of sampling in a frequency curve, determined by the method of moments from 1000 observations. When the eccentricities are of the order of magnitude of 0·9 the accuracy may be compared to that of a curve determined from 250 observations.

The above comparison with the errors of sampling only purposes to give a general idea of the order of magnitude of the perturbations caused by the eccentricities. Contrary to the errors of sampling the eccentricities cause systematic deviations and there is, of course, only a small chance of the errors of sampling affecting all the moments in the same direction and by amounts equal to the standard deviations.

10. It has so far been assumed that the corpuscles are ellipsoidal and of constant form. It will be seen, however, that the results obtained in equations (23) to (28) are still valid, if the eccentricities vary, provided the forms of the corpuscles are independent of ρ, that is of their volume. The only difference in such a case is, as seen from (11), that the coefficients λ_s are now equal to the mean value of the λ's determined by equation (12) for each separate combination of eccentricities occurring. Thus in expansions of the form (14) the different powers and product powers of the eccentricities should simply be replaced by the corresponding moments and product moments of e_2 and e_3.

I think it will be practicable to distinguish two different cases of varying eccentricity. The first case to be considered will be one of corpuscles having what may be called *a spherical type*. By this I mean the case where the corpuscles are generally of a spherical or only slightly eccentric form, more eccentric forms only occurring as more or less rare exceptions. In such a case our previous results clearly imply that the observations may safely be treated by the spherical methods of reduction. Because in such a case the coefficients λ_2 must be approximately equal to unity, as the major part of the individual λ's, defined for each corpuscle by the equation (12), of which the total λ's are the mean values, are then nearly equal to unity. The greater values of the individual λ's of the exceptional, very eccentric corpuscles, will not be sufficient seriously to disturb this tendency.

The second case will be one of what may be called *an eccentric type*. By this I mean a case where the bulk of the corpuscles are ellipsoidal with a considerable

eccentricity (upwards of or above 0·7) and where deviations from this type are the exceptions. Such cases may be rare in anatomical practice, but in other fields they are probably rather the rule. In studying different granulary minerals the usual method is to grind out a thin plane layer from the mineral, and the problem is, exactly as in the anatomical case, to draw conclusions as to the structure of the material from observations performed in a magnification of this sample. In several minerals, however, the corpuscles, or grains, are of more or less constant eccentric form.

But as the form which dominates in the materials mentioned is generally that of an ellipsoid of revolution, mostly of prolate form, I shall show in the following section, by a very simple device, how the problem may always be treated by the spherical method, in the case where the corpuscles are prolate (or oblate) ellipsoids of revolution.

11. As stated in § 2 the fundamental equation I is also valid if we let x and r denote, for example, any two corresponding principal diameters of the section and central ellipse respectively. If the corpuscles are all prolate ellipsoids of revolution it is evident that the minor diameter σ of the central ellipse will always be equal to the diameter s at right angles to the axis of revolution of the corpuscle. Thus if we observe the minor diameters, ξ, of the section ellipses we have the relation

$$\phi(\xi) = \xi \int_{\xi}^{R} \frac{f(s)\,ds}{s\sqrt{s^2 - \xi^2}},$$

where $f(s)$ is the frequency function of the diameter at right angles to the axis of revolution for the corpuscles contained in the section. The function $\phi(\xi)$, of course, denotes the frequency function of the observed minor diameters in the corresponding section ellipses. Furthermore, we have, as in the general case, the relation II, which here takes the form

$$f(s) = F(s)\frac{h_s}{h_0}.$$

Here $F(s)$ is the frequency function of s for the corpuscles in general and h_s is the regression of the "height" h on s. And h_0 is, as before, the general mean of h. But, denoting by v the angle between the normal to the section plane and the axis of revolution, we have

$$h = s\sqrt{\frac{1 - e^2\sin^2 v}{1 - e^2}} \qquad \text{.....(29).}$$

Now, as the factor s is not a function of the angle v (which would have been the case if we had used the geometric mean of the principal diameters or, indeed, any diameter but the minor diameter as measure), and assuming as before that the direction parameter v varies independently of the "size" s (and, if variable, also that the eccentricity e varies independently of s) it follows from this equation that we have

$$\frac{h_s}{h_0} = \frac{s}{s_0},$$

and thus that

$$F(s) = \frac{s_0}{s} f(s).$$

It is thus seen that we have exactly the same relations between the functions F and ϕ as in the case of spherical corpuscles. Hence, applying the reductions deduced for the case of spherical corpuscles to the distribution of the *minor* diameters in the section ellipses, we obtain the distribution of the *minor* diameters of the corpuscles, if they are all prolate ellipsoids of revolution. This is completely independent of the way in which the directions of the axes of revolution vary, and also of the way in which the eccentricities may vary, provided only that both are uncorrelated with the minor diameter.

It is evident that the same result will hold if the corpuscles are all *oblate* ellipsoids of revolution, if we then apply the spherical reductions to the distribution of the *major* diameters in the section ellipses. The result obtained will be the distribution of the *major* diameters of the corpuscles.

But there is one respect in which an assumption as to the way in which the directions and eccentricities vary must be made. This is when it is required to find the number N of corpuscles, per unit volume in the material investigated, from the number n of section ellipses, per unit area in the section. Clearly we have

$$h_0 N = n.$$

But from (29) we have

$$h_0 = s_0 M\left(\sqrt{\frac{1-e^2\sin^2 v}{1-e^2}}\right) = s_0 k_0,$$

if the corpuscles are prolate, and s_0 = mean of minor diameter,

and $$h_0 = s_0 M\left(\sqrt{1-e^2\cos^2 v}\right) = s_0 k_0',$$

if the corpuscles are oblate, and s_0 = mean of major diameter.

Here s_0 is determined in exactly the same manner as r_0 in the spherical case (see for instance the numerical examples in § 10 of previous paper).

If the directions are haphazard the probability that v falls in the interval v to $v+dv$ is equal to $\sin v\, dv$. Thus, as

$$\int_0^{\frac{\pi}{2}} dv \sin v \sqrt{1-e^2\sin^2 v} = \frac{1}{2}\left(1 + \frac{1-e^2}{2e}\ln\frac{1+e}{1-e}\right);$$

$$\int_0^{\frac{\pi}{2}} dv \sin v \sqrt{1-e^2\cos^2 v} = \frac{1}{2}\left(\sqrt{1-e^2} + \frac{1}{e}\arcsin e\right),$$

we have, in the case of constant eccentricity,

$$k_0 = \frac{1}{2}\left(\frac{1}{\sqrt{1-e^2}} + \frac{\sqrt{1-e^2}}{2e}\ln\frac{1+e}{1-e}\right); \quad k_0' = \frac{1}{2}\left(\sqrt{1-e^2} + \frac{1}{e}\arcsin e\right),$$

and, if e varies independently of s, the mean values of those functions of e should be taken.

Finally, if it be required to find, from the distribution $F(s)$ of the diameter s at right angles to the axis of revolution, the distribution $P(\rho)$ of the geometric mean diameter ρ, we have, in the case where the corpuscles are all prolate,

$$\rho = s\,.\,(1-e^2)^{-\frac{1}{4}},$$

and in the case where the corpuscles are all oblate,

$$\rho = s \cdot (1 - e^2)^{\frac{1}{2}}.$$

Thus, if the eccentricity does not vary, we have only to change the scale of the abscissa in order to pass over from $F(s)$ to $P(\rho)$. In the case where the eccentricity varies (independently of s, as we have already been compelled to assume) the distribution of ρ may be obtained from the distribution of s, by the aid of the following relations between the moments of ρ and of s:

For prolate corpuscles:

$$M(\rho^t) = M(s^t) \cdot M((1 - e^2)^{-\frac{t}{6}}).$$

For oblate corpuscles:

$$M(\rho^t) = M(s^t) \cdot M((1 - e^2)^{\frac{t}{6}}).$$

If it be not justifiable to assume the eccentricity to vary independently of s, but it be found more natural to assume it independent of ρ (that is of the volume of the corpuscle), then of course the solution is obtained from the solution given for general tri-axial ellipsoids, by putting $e_2 = e_3 = e$, $e_2 = e$, $e_3 = 0$, respectively. In such cases, however, it will be necessary to know, at least approximately, the distribution of the eccentricity. Having determined this distribution, the mean values of the coefficients λ_s will be readily determined by the aid of Tables I and II.

I have therefore, in the next section, tried to give a method of determining, for the case of ellipsoids of revolution, the distribution of the actual eccentricities of the corpuscles from the distribution of the observed eccentricities of the section ellipses.

12. Supposing the corpuscles to be *prolate* ellipsoids of revolution with a variable eccentricity e of the generating ellipse, it is easily shown that the eccentricity ϵ of the central ellipse is given by the equation

$$\epsilon = e \sin v \quad \ldots\ldots\ldots\

is not identical to the frequency function $\psi(\epsilon)$ of the eccentricities of the observed section ellipses. The reason for this is, of course, that the section contains corpuscles which are, in a certain way, selected with regard to the eccentricity ϵ.

We have $$h = S\sqrt{1 - e^2 \sin^2 v} = S\sqrt{1 - \epsilon^2},$$

if S is the major diameter of the corpuscle. Clearly,

$$n\psi(\epsilon) = N\pi(\epsilon) h_\epsilon,$$

where h_ϵ is the regression of h on ϵ. But we have, as before, $n = Nh_0$, h_0 being the total mean of h. Thus we must have

$$\psi(\epsilon) = \frac{h_\epsilon}{h_0}\pi(e) \quad \text{.....(32).}$$

We shall now regard three different cases: (1) that e varies independently of the major diameter S, (2) that it varies independently of the minor diameter s, and (3) that it varies independently of the volume, i.e. of the "diameter" ρ. At the same time we shall always suppose that the angle v is independent of e and ρ. It will then also be independent of S and s. Thus the three assumptions considered also imply that ϵ is independent of S, s and ρ, respectively.

Case 1. We here have

$$h_\epsilon = S_0\sqrt{1 - \epsilon^2},$$

S_0 being the mean of S. Furthermore

$$h_0 = S_0 . M(\sqrt{1 - \epsilon^2}) = S_0\delta_0.$$

We consequently get the relation

$$\psi(\epsilon) = \frac{1}{\delta_0}\sqrt{1 - \epsilon^2} . \pi(\epsilon),$$

or

$$\psi(\epsilon) = \frac{1}{\delta_0}\epsilon\sqrt{1 - \epsilon^2}\int_\epsilon^1 \frac{F(e)\,de}{e\sqrt{e^2 - \epsilon^2}} \quad \text{.....(33).}$$

Case 2. We here have

$$h = s(1 - e^2)^{-\frac{1}{2}}\sqrt{1 - \epsilon^2}.$$

But the correlation function of e and ϵ is clearly given by

$$\frac{\epsilon F(e)}{e\sqrt{e^2 - \epsilon^2}}.$$

Hence we find

$$\pi(\epsilon) h_\epsilon = s_0\sqrt{1 - \epsilon^2} . \epsilon\int_\epsilon^1 \frac{F(e)(1 - e^2)^{-\frac{1}{2}}\,de}{e\sqrt{e^2 - \epsilon^2}}.$$

As furthermore we now have

$$h_0 = s_0 M((1 - e^2)^{-\frac{1}{2}}\sqrt{1 - \epsilon^2}) = s_0\delta_0',$$

we get by the aid of (32):

$$\psi(\epsilon) = \frac{1}{\delta_0'}\epsilon\sqrt{1 - \epsilon^2}\int_\epsilon^1 \frac{F(e)(1 - e^2)^{-\frac{1}{2}}\,de}{e\sqrt{e^2 - \epsilon^2}}.$$

Case 3. As in this case

$$h = \rho(1 - e^2)^{-\frac{1}{3}}\sqrt{1 - \epsilon^2},$$

we have the following integral equation:

$$\psi(\epsilon) = \frac{1}{\delta_0''}\,\epsilon\sqrt{1-\epsilon^2}\int_\epsilon^1 \frac{F(e)(1-e^2)^{-\frac{1}{3}}\,de}{e\sqrt{e^2-\epsilon^2}}.$$

Here the constant δ_0'', which, as well as the constants δ_0 and δ_0', is incidentally of no importance as being only a proportional factor, is defined by the relation

$$\delta_0'' = M[(1-e^2)^{-\frac{1}{3}}\sqrt{1-\epsilon^2}].$$

By the so-called "spherical reduction," for which several methods of procedure were discussed in my previous paper, we actually solve an integral equation of the following form:

$$\psi(x) = kx\int_x^R \frac{F(r)\,dr}{\sqrt{r^2-x^2}}.$$

We thus arrive at the following remarkable rule for determining the distribution of the eccentricity in the case where the corpuscles may be regarded as prolate ellipsoids of revolution: *Dividing the series of ordinates $\psi(\epsilon)$ of the observed distribution of the eccentricities, ϵ, in the section ellipses, by $\sqrt{1-\epsilon^2}$, and applying the "spherical reduction" to the resulting series (for instance, by inserting it in equations* (18) *of the previous paper), we get a series of reduced "frequencies," which, if multiplied by e, $e(1-e^2)^{\frac{1}{2}}$ and $e(1-e^2)^{\frac{1}{3}}$, respectively, are proportional to the ordinates of the frequency function of e, according as e may be assumed to vary independently of the major diameters, the minor diameters, or the volumes of the corpuscles.*

If the corpuscles are *oblate* ellipsoids of revolution, we get instead, putting

$$\epsilon' = \frac{\epsilon}{\sqrt{1-\epsilon^2}}, \quad e' = \frac{e}{\sqrt{1-e^2}},$$

$$\epsilon' = e'\sin v, \qquad h = s\sqrt{1+\epsilon'^2}.$$

Hence, in a similar manner to the above, we here get the integral equation

$$\psi_1(\epsilon') = \frac{1}{\delta_0}\,\epsilon'\sqrt{1+\epsilon'^2}\int_{\epsilon'}^\infty \frac{F_1(e')(1+e'^2)^a\,de'}{e'\sqrt{e'^2-\epsilon'^2}},$$

where $a=0$ when e is independent of the minor diameter s, $a=-\frac{1}{2}$ when e is independent of the major diameter S, and $a=-\frac{1}{3}$ when e is independent of the volume of the corpuscles.

As the frequency functions $\psi(\epsilon)$ and $F(e)$ of ϵ and e are expressed in terms of the frequency functions $\psi_1(\epsilon')$ and $F_1(e')$ of ϵ' and e' by the simple relations

$$\psi(\epsilon) = \psi_1(\epsilon')(1+\epsilon'^2)^{\frac{3}{2}}; \quad F(e) = F_1(e')(1+e'^2)^{\frac{3}{2}},$$

we see that the procedure of determining the actual eccentricity distribution from the observed eccentricity distribution is as readily performed in the oblate case as in the prolate.

13. For a complete solution of the ellipsoidal corpuscle problem it now only remains to find the number N of corpuscles, per unit volume of the material investigated, from the number n of corpuscle images, per unit area of the section. As in the spherical case we may here use two different methods, both very simple.

First method. As we have

$$n = Nh_0,$$

and

$$h_0 = \rho_0 \lambda_0,$$

we readily get N from n, as ρ_0 is the mean of ρ, which may be determined either from the harmonic mean of the observed x's, or directly from the distribution of ρ, obtained by the reduction.

Second method. Quite independently of any assumption as to the form of the corpuscles we must always have the total volume V of the corpuscles, per unit volume of the material, equal to the total area of the corpuscle contours, per unit area of the section. Hence V may be regarded as known. But the volume of an ellipsoidal corpuscle is equal to

$$\frac{\pi}{6} s_1 s_2 s_3 = \frac{\pi}{6} \rho^3.$$

Thus we have

$$V = \frac{\pi}{6} N \,.\, N_3' \quad \text{.....(34).}$$

As N_3' is the mean of ρ^3 and may be determined either from the moments v_2' and v'_{-1} of the observed x's, or directly from the distribution of ρ, obtained by the reduction, N is readily found from V.

14. Before concluding this investigation I shall discuss a special problem, which was recently put before me by a civil engineer, Mr R. Wijkander, and which I consider to be of interest in this connection. Mr Wijkander was investigating a material called *perlite*, which consists of pure iron, with corpuscles of *cementite* (Fe_3C). At a certain temperature the corpuscles are dissolved in the iron. The rapidity of this process depends, in the first place, on the total surface of the corpuscles.

The problem to be considered is consequently the following: *To find the total surface of the corpuscles, per unit volume of the material investigated, from observations in a thin sample section.*

When the corpuscles are spherical it follows immediately from equations (11) of my previous paper, that the required relative surface is equal to four times the total length of the observed diameters, per unit area of the section. For the total surface of the corpuscles is $N \,.\, N_2'\pi$; as $N_2'\pi = 4N_1'v_1'$, and as $n = N \,.\, N_1'$, we have

$$N \,.\, N_2'\pi = 4nv_1' = 4X \quad \text{.....(35),}$$

where X is the sum of the observed diameters, per unit area of the section.

This result also follows immediately from the fact that the section diameter may be regarded as the "image" in the section of an equatorial plane through the corpuscle, taken at right angles to the section. Thus exactly the same relation holds between the sum of the areas of the great circles of the corpuscles and the sum of the lengths of the section diameters as was pointed out in § 13 with regard to the corpuscle *volumes* and the section *areas*. But the surface of a sphere is

equal to four times the area of its great circle, and thus the same result is arrived at by very simple considerations.

In the general ellipsoidal case the problem may be solved in the following way: The surface of an ellipsoid having the principal diameters s_1, s_2 and s_3 and the principal eccentricities

$$e_2 = \sqrt{\frac{s_1^2 - s_2^2}{s_1^2}}, \quad e_3 = \sqrt{\frac{s_1^2 - s_3^2}{s_1^2}},$$

is known to be equal to

$$T = (s_1 s_2 s_3)^{\frac{2}{3}} \pi \,.\, \lambda\,(e_2, e_3) = \pi \rho^2 \lambda\,(e_2, e_3),$$

where $\lambda\,(e_2, e_3)$ is a function of the eccentricities, defined by the integral (compare Serret-Scheffer, *loc. cit.*, § 592),

$$\lambda\,(e_2, e_3) = [(1 - e_2^2)(1 - e_3^2)]^{\frac{1}{6}} \int_0^1 \int_0^{\sqrt{1-x^2}} \frac{\sqrt{1 + e_2^2 x^2 + e_3^2 y^2}}{\sqrt{1 - x^2 - y^2}}\, dx dy.$$

Comparing with (12) and (13) it is seen that we have the following expansion of $\lambda\,(e_2, e_3)$:

$$\lambda\,(e_2, e_3) = [(1 - e_2^2)(1 - e_3^2)]^{\frac{1}{6}} [(1 + \tfrac{1}{6} p_2 - \tfrac{1}{40} p_4 + \tfrac{1}{112} p_6 - \tfrac{5}{1152} p_8 \ldots].$$

It may also, as shown by Legendre, be expressed in terms of normal elliptic integrals of the first and the second orders.

In the case of ellipsoids of revolution the function reduces to:

in the *prolate* case,

$$\lambda\,(e, e) = (1 - e^2)^{\frac{1}{3}} \frac{1}{2} \left[1 + \frac{1}{e\sqrt{1 - e^2}} \arcsin e\right]$$

= the λ_0 of formula (18 bis), tabulated in Table II,

and in the *oblate* case,

$$\lambda\,(e, 0) = (1 - e^2)^{-\frac{1}{3}} \frac{1}{2} \left[1 + \frac{1 - e^2}{2e} \ln \frac{1 + e}{1 - e}\right]$$

= the λ_0 of formula (17 bis), tabulated in Table I.

But the total surface, per unit volume of the material investigated, is

$$Y = NM\,(T) = N\pi N_2' \,.\, \lambda \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (36),$$

where λ is the mean of the function $\lambda\,(e_2, e_3)$, and it is assumed that the forms of the corpuscles are independent of their volumes.

In the case of ellipsoids of revolution of constant form it may be shown, in the same way as in the case of spherical corpuscles, that we have

$$Y = 4X \,.\, p\,(e),$$

where X is the sum per unit area of the section, of the major and minor diameters respectively, of the section ellipses according as the form is prolate or oblate. In the former case we have,

$$p\,(e) = \frac{1}{2} \left[\sqrt{1 - e^2} + \frac{1}{e} \arcsin e\right],$$

in the latter $$p(e) = \frac{1}{2\sqrt{1-e^2}}\left[1 + \frac{1-e^2}{2e}\ln\frac{1+e}{1-e}\right].$$

In many cases the relative surface required may be approximately determined when we only know n and V. As V in the *perlite* case and similar cases may be found from a chemical analysis of the material, this implies that the surface may be found without any observations at all in the section, except the number n of corpuscle contours per unit area. When the corpuscles are spherical the coefficient λ of equation (36) is equal to 1, and for the same reason as in the case of the functions λ_0, considered in §§ 7, 8 and 10, λ will not deviate much from unity, when the eccentricities are not on the average very great. From (34) and (36) we thus obtain the formula

$$Y = N_2' \sqrt{\frac{6\pi}{N_1' N_3'}} \sqrt{n \,.\, V} = K \sqrt{n \,.\, V}.$$

If we assume the diameter of the corpuscles to be distributed according to the type xe^{-x^2}, considered in § 6 of my previous paper, we get $K = 4$. Only for rather special forms of the size distribution will K differ sensibly from this value.

A FURTHER NOTE ON THE DISTRIBUTION OF RANGE IN SAMPLES TAKEN FROM A NORMAL POPULATION.

By EGON S. PEARSON, D.Sc.

Towards the end of his paper on "The Extreme Individuals and the Range of Samples taken from a Normal Population*," Mr L. H. C. Tippett has considered a method of obtaining the moments of the range from the moments of the correlation surface of the two extreme individuals of a sample. If u and v are the largest and smallest values of the character found among the individuals of the sample, and w the range which is given by $w = u - v$, then he gives the following perfectly general relations for the moments of the distribution of w,

$$\left.\begin{aligned} \overline{w} &= \bar{u} - \bar{v} \\ {}_w\mu_2 &= 2\,{}_u\mu_2\,(1 - r) \\ {}_w\mu_3 &= 2\,{}_u\mu_3 + 6p_{12} \\ {}_w\mu_4 &= 2\,{}_u\mu_4 - 8p_{13} + 6p_{22} \end{aligned}\right\} \quad \text{.....(i),}$$

where ${}_u\mu_2$, ${}_u\mu_3$, ${}_u\mu_4$ are the moment coefficients of the u margin†, and r, p_{11}, p_{12}, p_{13} and p_{22} the correlation and cross-product moment coefficients of the u, v frequency surface. Tippett has shown that for samples of size 60 or more the coefficient of correlation between u and v is practically negligible, and on the assumption that the regression will then be approximately linear and the distribution homoscedastic, he makes use of the simple relations (ii) to obtain the moments of the w distribution:

$$\left.\begin{aligned} {}_w\mu_2 &= 2\,{}_u\mu_2 \\ {}_w\mu_3 &= 2\,{}_u\mu_3 \\ {}_w\mu_4 &= 2\,{}_u\mu_4 + 6\,{}_u\mu_2^2 \end{aligned}\right\} \quad \text{.....(ii).}$$

In small samples the correlation will not vanish nor will the regression be linear; for this reason and also if possible to test more rigorously the validity of the assumptions made in the case of large samples, it is of interest to consider the general expression for the u, v surface. This can be readily obtained by introducing a geometrical conception.

Suppose that $\phi_n(u, v)$ is the correlation surface for u and v in samples of n; as $u \geqslant v$ this surface must lie wholly to the left-hand side of the line $u = v$, or AOB (Fig. 1). If now samples of $n + 1$ are taken, the surface $\phi_n(U, V)$ will differ from $\phi_n(u, v)$ because the $n + 1$th individual, which we may consider as that last drawn, will

* *Biometrika*, Vol. XVII. p. 364.

† The distributions in the u and v margins are identical but reversed so that

$$\bar{u} = -\bar{v}, \quad {}_u\mu_2 = {}_v\mu_2, \quad {}_u\mu_3 = -{}_v\mu_3, \quad {}_u\mu_4 = {}_v\mu_4, \quad p_{12} = -p_{21}, \quad p_{13} = p_{31}.$$

sometimes be $> u$ and sometimes $< v$. That is to say in a sample of $n+1$ we have n individuals for which the highest and lowest values of the variate follow a frequency distribution $\phi_n(u, v)$ and a single individual (if we are sampling from a normal population with unit standard deviation) with distribution

$$\frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2},$$

with no correlation between x and u, or x and v. Of all possible samples of $n+1$, consider those only in which the $n+1$th individual lies between x and $x+dx$; three cases occur.

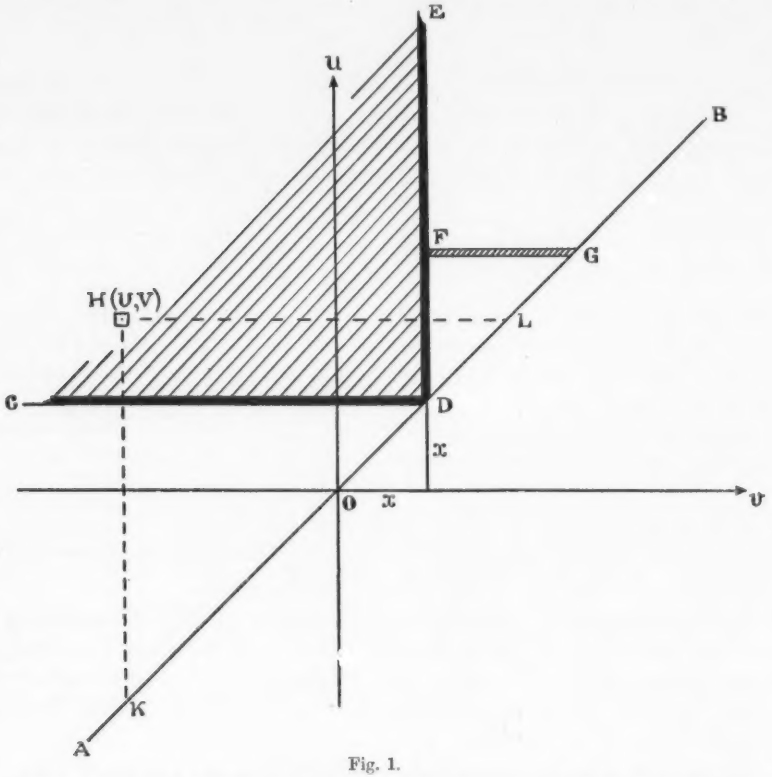


Fig. 1.

1. $u > x > v$, so that $U = u$, $V = v$. Here the frequency distribution of U and V will be as for u and v, or $\phi_{n+1}(U, V)$ will consist of superimposed parts of which one is the "slice" of $\phi_n(u, v)$ standing on the sector CDE which is shaded in the figure, D being the point (x, x).

2. $u > v > x$, so that $U = u$, $V = x$. In this case the contribution to $\phi_{n+1}(U, V)$ is a strip of frequency of width dx lying along the line DE, such that the frequency

standing on an element $dU\,dx$ at any point F equals the frequency of $\phi_n(u, v)$ standing on the strip FG of breadth dU; but this is

$$dU \int_x^U \phi_n(U, v)\, dv.$$

The "slice" of $\phi_n(u, v)$ lying above the sector EDB contributes in fact to $\phi_n(U, V)$ a narrow strip of the same volume lying along DE.

3. $x > u > v$, so that $U = x$, $V = v$. In this case the contribution to $\phi_{n+1}(U, V)$ is a strip of frequency of width dx lying along the line DC, giving at any point V a frequency on the element $dV\,dx$ of

$$dV \int_V^x \phi_n(u, V)\, du.$$

The "slice" over CDA becomes a strip along DC.

To obtain the complete frequency surface $\phi_{n+1}(U, V)$ we have to sum the three contributions corresponding to every value of x possible. Now x varies between $-\infty$ and $+\infty$ with a proportional frequency

$$\frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2},$$

and as it varies D passes from one end to the other of the diagonal line AOB. Consider the contributions to a block $\phi_{n+1}(U, V)\, dU\, dV$ standing at H on a base $dU\, dV$.

Source 1. Will only contribute frequency when D, the point (x, x), lies between K and L. The total contribution is therefore

$$dU\, dV \int_V^U \phi_n(U, V) \frac{e^{-\frac{1}{2}x^2}}{\sqrt{2\pi}}\, dx = \phi_n(U, V)\, dU\, dV \int_V^U \frac{e^{-\frac{1}{2}x^2}}{\sqrt{2\pi}}\, dx.$$

Source 2. Will only provide a contribution when x is such that the line DE passes through H, or when $x = V$; it will then contribute

$$\frac{e^{-\frac{1}{2}V^2}}{\sqrt{2\pi}}\, dV \times dU \int_V^U \phi_n(U, v)\, dv.$$

Source 3. Will similarly only provide a contribution when $x = U$, so that DC passes through H; then the contribution will be

$$\frac{e^{-\frac{1}{2}U^2}}{\sqrt{2\pi}}\, dU \times dV \int_V^U \phi_n(u, V)\, du.$$

Hence it follows that

$$\phi_{n+1}(U, V) = \phi_n(U, V) \int_V^U \frac{e^{-\frac{1}{2}x^2}}{\sqrt{2\pi}}\, dx + \frac{e^{-\frac{1}{2}V^2}}{\sqrt{2\pi}} \int_V^U \phi_n(U, v)\, dv + \frac{e^{-\frac{1}{2}U^2}}{\sqrt{2\pi}} \int_V^U \phi_n(u, V)\, du \quad \text{.....(iii).}$$

Equation (iii) provides a reduction formula for obtaining the correlation surface of the values of characters of highest and lowest individuals in samples of n in terms of the equations of surfaces for smaller samples. Take the simplest case

where $n = 2$; the frequency surface for the two variates, if there is no restriction as to smaller or greater, is simply the normal surface

$$z = \frac{1}{2\pi} e^{-\frac{1}{2}(x^2+y^2)} \quad \text{.....(iv).}$$

We obtain the frequency surface for u and v by doubling this surface back over the line $x = y$, and have

$$z = \phi_2(u, v) = \frac{1}{\pi} e^{-\frac{1}{2}(u^2+v^2)} \quad \text{.....(v)}$$

as the correlation surface for u and v. The frequency is cut off abruptly along the line $u = v$. Now substitute (v) into (iii), and write

$$A_u = \int_{-\infty}^{u} \frac{e^{-\frac{1}{2}x^2}}{\sqrt{2\pi}}\, dx \quad \text{.....(vi),}$$

$$\phi_3(U, V) = \frac{e^{-\frac{1}{2}(U^2+V^2)}}{\pi}(A_U - A_V) + \frac{e^{-\frac{1}{2}V^2}}{\sqrt{2\pi}} \int_V^U \frac{e^{-\frac{1}{2}(U^2+v^2)}}{\pi}\, dv$$

$$+ \frac{e^{-\frac{1}{2}U^2}}{\sqrt{2\pi}} \int_V^U \frac{e^{-\frac{1}{2}(u^2+V^2)}}{\pi}\, du = \frac{3}{\pi} e^{-\frac{1}{2}(U^2+V^2)}(A_U - A_V) \text{ ...(vii).}$$

On substituting (vii) in (iii) it can be shown that

$$\phi_4(U, V) = \frac{6}{\pi} e^{-\frac{1}{2}(U^2+V^2)}(A_U - A_V)^2 \quad \text{.....(viii).}$$

What then is the general law? Assume

$$\phi_n(U, V) = c_n e^{-\frac{1}{2}(U^2+V^2)}(A_U - A_V)^{n-2} \quad \text{.....(ix).}$$

On substituting in (iii) it follows that

$$\phi_{n+1}(U, V) = c_n e^{-\frac{1}{2}(U^2+V^2)} \left\{ (A_U - A_V)^{n-1} + \int_V^U \frac{e^{-\frac{1}{2}v^2}}{\sqrt{2\pi}} (A_U - A_v)^{n-2}\, dv \right.$$

$$\left. + \int_V^U \frac{e^{-\frac{1}{2}u^2}}{\sqrt{2\pi}} (A_u - A_V)^{n-2}\, dv \right\}.$$

But

$$\frac{d}{dv}(A_U - A_v)^{n-1} = -(n-1)(A_U - A_v)^{n-2} \frac{dA_v}{dv}$$

$$= -(n-1)(A_U - A_v)^{n-2} \frac{e^{-\frac{1}{2}v^2}}{\sqrt{2\pi}} \text{ by (vi),}$$

$$\phi_{n+1}(U, V) = c_n e^{-\frac{1}{2}(U^2+V^2)} \left\{ (A_U - A_V)^{n-1} - \int_V^U \frac{d(A_U - A_v)^{n-1}}{dv} \frac{dv}{n-1} \right.$$

$$\left. + \int_V^U \frac{d(A_u - A_V)^{n-1}}{du} \frac{du}{n-1} \right\}$$

$$= c_n e^{-\frac{1}{2}(U^2+V^2)}(A_U - A_V)^{n-1} \left\{ 1 + \frac{1}{n-1} + \frac{1}{n-1} \right\},$$

$$\phi_{n+1}(U, V) = c_n \frac{n+1}{n-1} e^{-\frac{1}{2}(U^2+V^2)}(A_U - A_V)^{n-1} \quad \text{.....(x).}$$

The particular cases (v), (vii) and (viii) can therefore be generalised into (ix) or (x), and it only remains to find c_n. But $c_3 = 3/\pi$. Hence

$$c_n = \frac{3}{\pi} \cdot \frac{4}{2} \cdot \frac{5}{3} \cdots\cdots \frac{n}{n-2} = \frac{n(n-1)}{2\pi}.$$

The general correlation surface for u and v in samples of n is therefore finally*

$$z = \frac{n(n-1)}{2\pi} e^{-\frac{1}{2}(u^2+v^2)} (A_u - A_v)^{n-2} \quad \text{.....(xi),}$$

where

$$A_t = \int_{-\infty}^{t} \frac{e^{-\frac{1}{2}x^2}}{\sqrt{2\pi}} dx \quad \text{.....(vi) bis.}$$

The marginal distributions of this surface can be obtained as follows. The frequency for u between u and $u + du$ is

$$\begin{aligned} du \int_{-\infty}^{u} z\,dv &= du \frac{n(n-1)}{\sqrt{2\pi}} e^{-\frac{1}{2}u^2} \int_{-\infty}^{u} \frac{e^{-\frac{1}{2}v^2}}{\sqrt{2\pi}} (A_u - A_v)^{n-2} dv \\ &= -du \frac{n(n-1)}{\sqrt{2\pi}} e^{-\frac{1}{2}u^2} \int_{-\infty}^{u} (A_u - A_v)^{n-2} \frac{d(A_u - A_v)}{dv} dv \\ &= -du \frac{n(n-1)}{\sqrt{2\pi}} e^{-\frac{1}{2}u^2} \left[\frac{(A_u - A_v)^{n-1}}{n-1} \right]_{A_v = 0}^{A_v = A_u} \\ &= du \frac{n}{\sqrt{2\pi}} e^{-\frac{1}{2}u^2} A_u^{n-1}. \end{aligned}$$

Or the frequency distribution of u, the largest individual, is

$$y = \frac{n}{\sqrt{2\pi}} e^{-\frac{1}{2}u^2} A_u^{n-1} \quad \text{.....(xii).}$$

Similarly the frequency distribution of v is

$$y' = \frac{n}{\sqrt{2\pi}} e^{-\frac{1}{2}v^2} (1 - A_v)^{n-1} \quad \text{.....(xiii).}$$

It will be noticed that (xii) satisfies the relation given by Tippett in his equation (1), viz.

$$\int_{-\infty}^{u} y\,dx = A_u^n.$$

To find the distribution of the range, w, from equations (i) we need the moments and product moment coefficients of (xi) and (xii) up to the 4th order. The expressions involved cannot in general be integrated, but it has been possible to obtain a complete solution for the cases $n = 2, 3, 4, 5$ and 6, with the help of the following integrals whose numerical values were obtained by quadrature:

* It will be found, as of course should be the case, that $\int_{-\infty}^{+\infty} \int_{v}^{\infty} z\,du\,dv = 1$.

(*a*) $\int_{-\infty}^{+\infty} e^{-u^2} A_u^2\, du = \cdot 538\ 9796.$ (*e*) $\int_{-\infty}^{+\infty} e^{-\frac{3}{2}u^2} A_u^2\, du = \cdot 420\ 0004.$

(*b*) $\int_{-\infty}^{+\infty} e^{-u^2} A_u^3\, du = \cdot 365\ 3560.$ (*f*) $\int_{-\infty}^{+\infty} e^{-\frac{3}{2}u^2} A_u^3\, du = \cdot 268\ 2000.$

(*c*) $\int_{-\infty}^{+\infty} e^{-u^2} A_u^4\, du = \cdot 265\ 4030.$ (*g*) $\int_{-\infty}^{+\infty} e^{-2u^2} A_u^3\, du = \cdot 353\ 4936.$

(*d*) $\int_{-\infty}^{+\infty} e^{-\frac{1}{4}u^2} A_u^3 du = 1\cdot 297\ 9316.$

(*h*) $\int_{-\infty}^{+\infty} e^{-\frac{3}{2}u^2} A_u\, du \int_{-\infty}^{u} e^{-v^2}\, dv = \sqrt{\pi} \int_{-\infty}^{+\infty} e^{-\frac{3}{2}u^2} A_u A_{\sqrt{2}u}\, du = \cdot 772\ 6291.$

(*j*) $\int_{-\infty}^{+\infty} e^{-u^2} A_u\, du \int_{-\infty}^{u} e^{-\frac{3}{2}v^2}\, dv = \sqrt{\frac{2\pi}{3}} \int_{-\infty}^{+\infty} e^{-u^2} A_u A_{\sqrt{3}u}\, du = \cdot 830\ 5582.$

It will be seen that (xii) gives for the mean u,

$$ {}_n\bar{u} = \frac{n}{\sqrt{2\pi}} \int_{-\infty}^{+\infty} e^{-\frac{1}{2}u^2} u A_u^{n-1}\, du = \frac{n(n-1)}{2\pi} \int_{-\infty}^{+\infty} e^{-u^2} A_u^{n-2}\, du \ldots\ldots \text{(xiv)}, $$

on integrating by parts. The integrals (*a*), (*b*) and (*c*) above are respectively

(*a*) $\frac{1}{6}\pi\ {}_4\bar{u} = \frac{1}{12}\pi\ {}_4\bar{w}$, (*b*) $\frac{1}{10}\pi\ {}_5\bar{u} = \frac{1}{20}\pi\ {}_5\bar{w}$, (*c*) $\frac{1}{15}\pi\ {}_6\bar{u} = \frac{1}{30}\pi\ {}_6\bar{w}$,

giving values for the mean ranges ${}_4\bar{w}$, ${}_5\bar{w}$, ${}_6\bar{w}$ corresponding exactly with those tabled by Tippett*, although the form of integral which he has used for the mean, viz.

$$ {}_n\bar{w} = \int_{-\infty}^{+\infty} \{1 - (1 - A_u)^n - A_u^n\}\, du = \int_{-\infty}^{+\infty} (1 - 2A_u^n)\, du \ldots\ldots\ldots \text{(xv)}, $$

does not correspond with (xiv)†.

Making use of the numerical values of these integrals, (*a*)...(*j*), the constants of the five distributions can be found, and are given in Table I. From these can be obtained as a first objective, by using equations (i), the constants of the distribution of range in samples of 2, 3, 4, 5 and 6 individuals; they are given in Table II. Those for $n = 2$ were already known. In Figures 2 and 3 I have connected the values of σ_w and r with those of Tippett's for $n = 10$ and 20, which were obtained by computation without any assumptions as to the form of the u, v distribution. Figure 2 reproduces on a much enlarged scale the start of the curve given in Diagram VI of Tippett's paper; it can be readily used for interpolation of values of σ_w.

Our second purpose is to ascertain how nearly in the case of the constants ${}_w\beta_1$ and ${}_w\beta_2$ we have bridged the gap left open by Tippett, that is to say how nearly at $n = 6$ is there justification for assuming linear regression and homo-

* His Table X, p. 386, *loc. cit.*

† The two forms can be made equivalent by showing that in the limit $\left[u\,(2A_u^n - 1)\right]_{u=-\infty}^{u=+\infty} = 0$.

scedasticity in the u, v frequency surface? On these assumptions we should have

$$\left.\begin{aligned} p_{12} &= -r_u\mu_3 \\ p_{13} &= \quad r_u\mu_4 \\ p_{22} &= \{1 + r^2({}_u\beta_2 - 1)\}\,{}_u\mu_2^2 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\text{(xvi)},$$

which give for $n = 6$

$$\begin{aligned} p_{12} &= -\cdot012\,079 \text{ against true } +\cdot014\,490, \\ p_{13} &= +\cdot075\,781 \quad \text{,,} \quad \text{,,} \quad +\cdot067\,983, \\ p_{22} &= +\cdot180\,087 \quad \text{,,} \quad \text{,,} \quad +\cdot177\,403, \end{aligned}$$

and using equations (i)

$$\begin{aligned} {}_w\beta_1 &= \cdot0301 \text{ against true } \cdot1892, \\ {}_w\beta_2 &= 3\cdot0803 \quad \text{,,} \quad \text{,,} \quad 3\cdot1698, \end{aligned}$$

values which are far from satisfactory. In fact at $n = 6$ the regression is not linear nor is the distribution homoscedastic.

TABLE I.

Momental Constants of u, v Distribution.

Size of Sample, $n=$	2	3	4	5	6
Moments of u margin					
Mean	·564 190	·846 284	1·029 375	1·162 964	1·267 206
σ	·825 645	·747 975	·701 225	·668 981	·644 925
μ_2	·681 690	·559 467	·491 716	·447 535	·415 928
μ_3	·077 079	·089 199	·091 207	·090 585	·089 168
μ_4	1·422 797	·975 522	·764 597	·641 083	·559 440
β_1	·0188	·0454	·0700	·0915+	·1105+
β_2	3·0617	3·1166	3·1623	3·2008	3·2338
Cross-products					
r	·466 942	·294 688	·212 893	·165 831	·135 458
p_{11}	·318 310	·164 868	·104 683	·074 215	·056 341
p_{12}	·077 079	·045 761	·028 954	·019 858	·014 490
p_{13}	·622 273	·266 003	·149 071	·096 337	·067 983
p_{22}	·696 036	·370 644	·262 295	·209 221	·177 403

TABLE II.

Momental Constants of Range w.

Size of Sample, $n=$	2	3	4	5	6
Mean	1·1284	1·6926	2·0588	2·3259	2·5344
Standard Deviation	·8525+	·8884	·8798	·8641	·8480
β_1	·9906	·4174	·2735−	·2167	·1892
β_2	3·8692	3·2864	3·1884	3·1693	3·1698

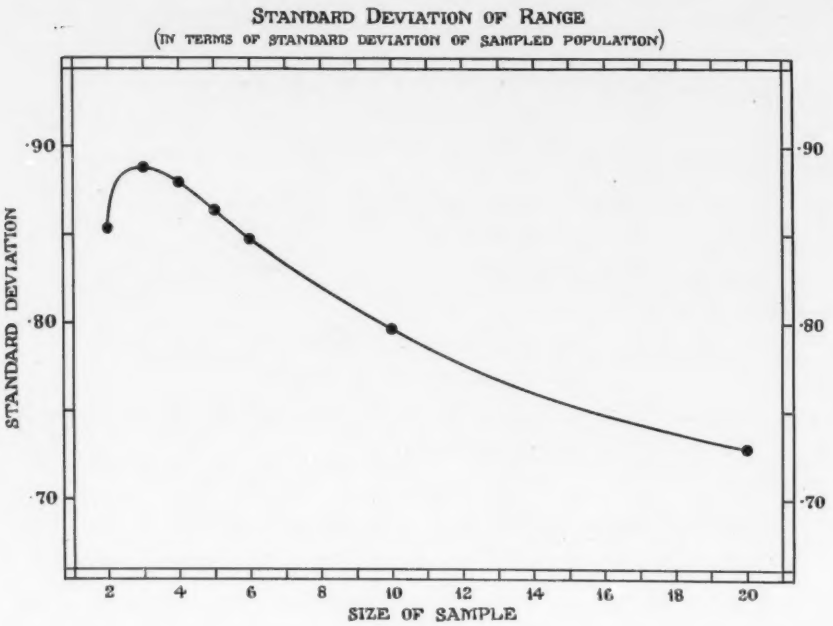

STANDARD DEVIATION OF RANGE
(IN TERMS OF STANDARD DEVIATION OF SAMPLED POPULATION)
STANDARD DEVIATION
·90
·80
·70
2
4
6
8
10
12
14
16
18
20
SIZE OF SAMPLE

Fig. 2.

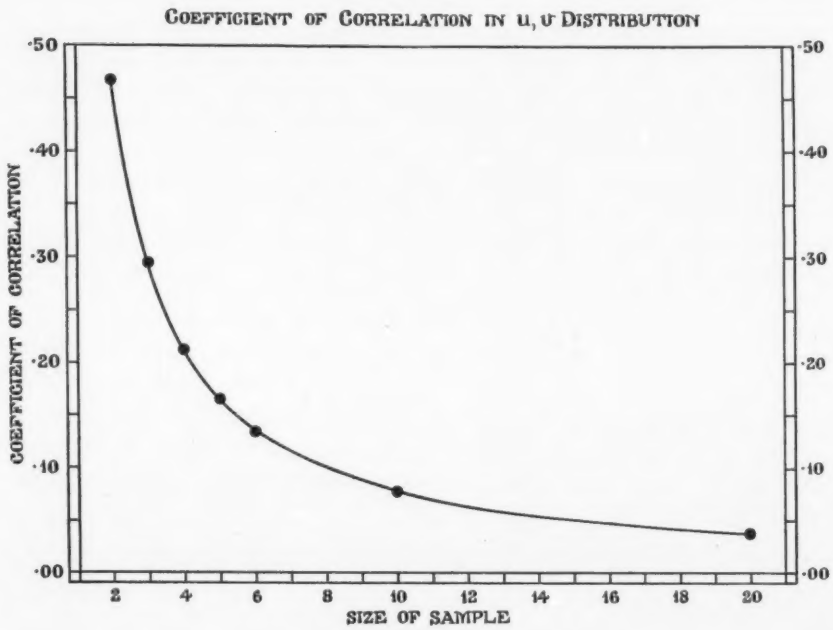

COEFFICIENT OF CORRELATION IN u, v DISTRIBUTION
COEFFICIENT OF CORRELATION
·50
·40
·30
·20
·10
·00
2
4
6
8
10
12
14
16
18
20
SIZE OF SAMPLE

Fig. 3.

From (xi) and (xiii) we have that the mean value of u for a given v is

$$ {}_n\bar{u}_v = \frac{n-1}{\sqrt{2\pi}} \frac{1}{(1-A_v)^{n-1}} \int_v^\infty u e^{-\frac{1}{2}u^2} (A_u - A_v)^{n-2} du $$

$$ = \frac{(n-1)(n-2)}{2\pi} \frac{1}{(1-A_v)^{n-1}} \int_v^\infty e^{-u^2} (A_u - A_v)^{n-3} du \quad \ldots\ldots\text{(xvii)} $$

on reduction.

Similarly the mean value of u^2 for a given v is, after reduction,

$$ {}_n\sigma^2_{u_v} + ({}_n\bar{u}_v)^2 = 1 + \frac{(n-1)(n-2)(n-3)}{4\pi\sqrt{2\pi}} \frac{1}{(1-A_v)^{n-1}} \int_v^\infty e^{-\frac{1}{2}u^2} (A_u - A_v)^{n-4} du $$

$$ \ldots\ldots\ldots\ldots\text{(xviii)}. $$

From the computations already made in obtaining the numerical values of the integrals $(a)\ldots(j)$, ${}_n\bar{u}_v$ and ${}_n\sigma^2_{u_v}$ were readily obtained from (xvii) and (xviii) for the case $n = 6$, and their values at intervals of v of 0·5* are given in Table III. The distribution within the range $\bar{v} \pm 3\sigma_v$ is illustrated in Figure 4; it will be seen that towards the left-hand side of the diagram there is a condition approaching linearity of regression and homoscedasticity, but that as v increases, the regression

TABLE III.

Regression and Scedasticity of u, v Distribution in a Sample of 6.

	$\bar{u}_v$	$\sigma^2_{u_v}$	σ_{u_v}	Parabola (xxvii) $\bar{u}_v$	Expansions in A_v of p. 185 $\bar{u}_v$	σ_{u_v}
+1·0	2·100	·2191	·468	1·951	1·950+	·396
+0·5	1·809	·2573	·507	1·730	1·765−	·476
0·0	1·570	·3094	·556	1·545	1·562	·547
−0·5	1·391	·3613	·601	1·396	1·391	·598
−1·0	1·274	·4009	·633	1·283	1·274	·633
−1·5	1·208	·4274	·654	1·206	1·208	·654
−2·0	1·178	·4404	·664	1·165+	1·178	·664
−2·5	1·167	·4457	·668	1·161	1·167	·668
−3·0	1·164	·4470	·669	1·193	1·164	·669

line begins to rise rapidly and the scedasticity to decrease. To understand the general significance of these features, let us consider the limits of ${}_n\bar{u}_v$ and ${}_n\sigma^2_{u_v}$.

(1) As $v \to -\infty$ and $A_v \to 0$,

$$ {}_n\bar{u}_v \to \frac{(n-1)(n-2)}{2\pi} \int_{-\infty}^{+\infty} e^{-u^2} A_u^{n-3} du, $$

$$ \to {}_{n-1}\bar{u} \quad \text{from (xiv)}, $$

or the array means tend to the mean value of u in a sample of $n-1$ individuals.

(2) As $v \to +\infty$ and $A_v \to 1$, (xvii) becomes zero in numerator and denominator. But after $n-1$ differentiations it is found that $\underset{v \to +\infty}{\text{Lt}} ({}_n\bar{u}_v) = v$, or the regression line is asymptotic to the line $u = v$.

* The unit of u and v is, as always, the standard deviation of the original normal population from which the sample has been drawn.

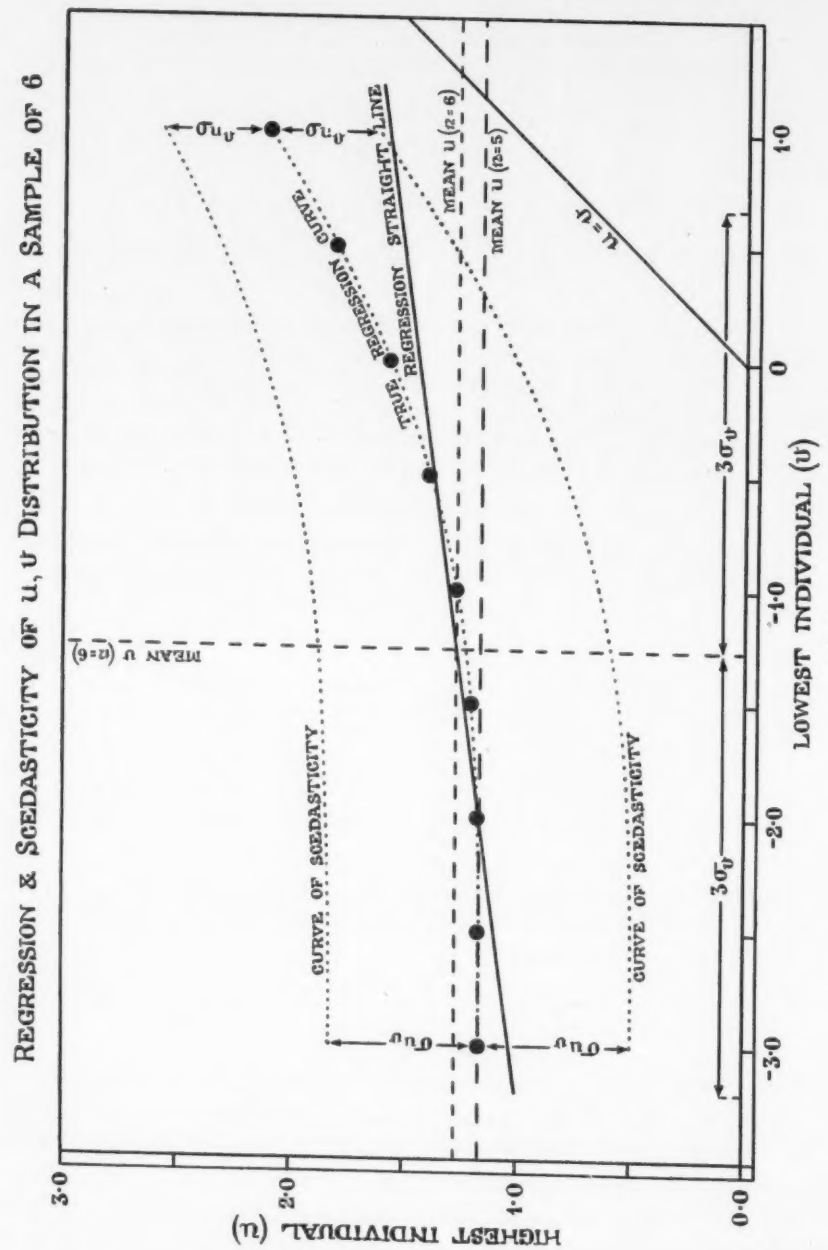

REGRESSION & SCEDASTICITY OF u, v DISTRIBUTION IN A SAMPLE OF 6
HIGHEST INDIVIDUAL (u)
LOWEST INDIVIDUAL (v)
3·0
2·0
1·0
0·0
-3·0
-2·0
-1·0
0
1·0
MEAN v (n=6)
CURVE OF SCEDASTICITY
TRUE REGRESSION STRAIGHT LINE
TRUE REGRESSION CURVE
MEAN u (n=6)
MEAN u (n=5)
u = v
3σv
3σv
σuv
σuv
σuv
σuv

Fig. 4.

${}_n\bar{u}_v$ approaches ${}_{n-1}\bar{u}$ far more rapidly in the negative direction than it approaches $u=v$ in the positive direction, as is illustrated in Figure 4, but it is clear that however great n may be, the regression can never be strictly linear. r, the coefficient of correlation between u and v, is found to tend to zero as n increases, simply because within the range of significant frequency—let us say $u=\bar{u}\pm 3\sigma_u$, $v=\bar{v}\pm 3\sigma_v$—the regression line is effectively a horizontal straight line.

To find the limits of ${}_n\sigma^2{}_{u_v}$ we note that the second moment of u (or v) about the origin is

$$ {}_n\mu_2' = 1 + \frac{n(n-1)(n-2)}{4\pi\sqrt{2\pi}} \int_{-\infty}^{+\infty} e^{-\frac{3}{2}u^2} A_u{}^{n-3}\, du \quad \ldots\ldots\ldots\ldots\text{(xix)}. $$

Then,

(1) As $v\to-\infty$ and $A_v\to 0$,

$$ {}_n\sigma^2{}_{u_v} + ({}_n\bar{u}_v)^2 \to 1 + \frac{(n-1)(n-2)(n-3)}{4\pi\sqrt{2\pi}} \int_{-\infty}^{+\infty} e^{-\frac{3}{2}u^2} A_u{}^{n-4} $$

$$ \to {}_{n-1}\mu_2' \text{ or } {}_{n-1}\sigma_u{}^2 + {}_{n-1}\bar{u}^2. $$

Hence as

$$ {}_n\bar{u}_v \to {}_{n-1}\bar{u}, $$

$$ {}_n\sigma_{u_v} \to {}_{n-1}\sigma_u, $$

or the standard deviation in the array tends to the standard deviation of u in a sample of $n-1$.

(2) By $n-1$ successive differentiations of numerator and denominator of (xviii) it is found that,

As $v\to+\infty$ and $A_v\to 1$,

$$ {}_n\sigma^2{}_{u_v} + ({}_n\bar{u}_v)^2 \to 1 + (v^2-1) $$

$$ \to v^2. $$

Hence $\underset{v\to+\infty}{\text{Lt}}\ {}_n\sigma^2{}_{u_v} = 0$, or for high values of v, the scedasticity tends to vanish.

Here again we see that however large the sample, we shall not obtain theoretical homoscedasticity over the whole surface, but as in the case of the regression it may be possible to show that this holds effectively in the region of significant frequency. If we take $\bar{v}+3\sigma_v$ as the maximum value of the character of the lowest individual likely to be met with in a sample, and therefore as a practical limit on one side to the u, v surface, we obtain the values given in Table IV*. For

TABLE IV.

Values of A_v, etc. at Limit of Significant Frequency.

Size of Sample	$v=\bar{v}+3\sigma_v$	A_v	$A_v{}^2$	$A_v{}^3$
6	+ ·67	·7486	·5604	·4195
20	− ·29	·3859	·1489	·0575
60	− ·96	·1685	·0284	·0048
100	− 1·22	·1112	·0124	·0014
500	− 1·93	·0268	·0007	·0000

* Using values of σ_v given in Tippett's Table I, except for $n=6$.

samples of 60 or more, A_v is seen to be very small in the range of significant frequency, and this suggests that we should expand (xvii) and (xviii) in powers of A_v.

Write $$F_n(A_v) = \int_v^\infty e^{-ku^2}(A_u - A_v)^n\,du \quad \text{.....(xx).}$$

Then

$$\frac{\partial F}{\partial v} = \frac{\partial}{\partial v}\left\{\int_v^\infty e^{-ku^2}A_u{}^n\,du - nA_v\int_v^\infty e^{-ku^2}A_u{}^{n-1}\,du + \frac{n(n-1)}{2!}A_v{}^2\int_v^\infty e^{-ku^2}A_u{}^{n-2}\,du \ldots (-1)^n A_v{}^n\int_v^\infty e^{-ku^2}\,du\right\}$$

$$= -e^{-kv^2}A_v{}^n\left(1 - n + \frac{n(n-1)}{2!} - \ldots (-1)^n\right)$$

$$- n\frac{e^{-\frac{1}{2}v^2}}{\sqrt{2\pi}}\left\{\int_v^\infty e^{-ku^2}A_u{}^{n-1}\,du - (n-1)A_v\int_v^\infty e^{-ku^2}A_u{}^{n-2}\,du + \frac{(n-1)(n-2)}{2!}A_v{}^2\int_v^\infty e^{-ku^2}A_u{}^{n-3}\,du \ldots (-1)^{n-1}A_v{}^{n-1}\int_v^\infty e^{-ku^2}\,du\right\}$$

$$= 0 - n\frac{e^{-\frac{1}{2}v^2}}{\sqrt{2\pi}}F_{n-1}(A_v) = -n\frac{dA_v}{dv}F_{n-1}(A_v).$$

But $$\frac{\partial F}{\partial A_v} = \frac{\partial F}{\partial v}\Big/\frac{dA_v}{dv} = -nF_{n-1}(A_v),$$

and similarly $$\frac{\partial^2 F}{\partial A_v{}^2} = n(n-1)F_{n-2}(A_v),$$

$$\frac{\partial^3 F}{\partial A_v{}^3} = n(n-1)(n-2)F_{n-3}(A_v), \text{ etc.}$$

It follows that if $F_n(A_v)$ may be expanded in a Maclaurin series, then

$$\int_v^\infty e^{-ku^2}(A_u - A_v)^n\,du = \int_{-\infty}^{+\infty} e^{-ku^2}A_u{}^n\,du - nA_v\int_{-\infty}^{+\infty} e^{-ku^2}A_u{}^{n-1}\,du + \frac{n(n-1)}{2!}A_v{}^2\int_{-\infty}^{+\infty} e^{-ku^2}A_u{}^{n-2}\,du - \ldots \quad \text{.....(xxi).}$$

Expanding $\dfrac{1}{(1-A_v)^{n-1}}$ in ascending powers of A_v, and remembering that the integrals in (xxi), when multiplied by the appropriate factors,

(a) become the successive marginal means, ${}_n\bar{u}$, ... when $k = 1$ (see (xiv)),

(b) " " " second moments, ${}_n\mu_2'$, ... when $k = \frac{3}{2}$ (see (xix)),

it can be shown after some reduction of (xvii) and (xviii) that

$${}_n\bar{u}_v = {}_{n-1}\bar{u} + (n-1)A_v({}_{n-1}\bar{u} - {}_{n-2}\bar{u}) + \frac{(n-1)}{2!}A_v{}^2\{(n-2)_{n-3}\bar{u} - 2(n-1)_{n-2}\bar{u} + n_{n-1}\bar{u}\} + \frac{n-1}{3!}A_v{}^3\{n(n+1)_{n-1}\bar{u} - 3n(n-1)_{n-2}\bar{u} + 3(n-1)(n-2)_{n-3}\bar{u} - (n-2)(n-3)_{n-4}\bar{u}\} + \ldots \quad \text{...(xxii),}$$

$$
\begin{aligned}
{}_n\sigma^2{}_{u_v} = {}&{}_{n-1}\sigma_u{}^2 + (n-1)\,A_v\,\{{}_{n-1}\sigma_u{}^2 - {}_{n-2}\sigma_u{}^2 - ({}_{n-1}\bar{u} - {}_{n-2}\bar{u})^2\} \\
&+ \frac{n-1}{2\,!}\,A_v{}^2\,[(n-2)\,{}_{n-3}\sigma_u{}^2 - 2\,(n-1)\,{}_{n-2}\sigma_u{}^2 + n\,{}_{n-1}\sigma_u{}^2 \\
&\qquad + (n-2)\,({}_{n-1}\bar{u} - {}_{n-3}\bar{u})^2 - 4\,(n-1)\,({}_{n-1}\bar{u} - {}_{n-2}\bar{u})^2\} \\
&+ \frac{n-1}{3\,!}\,A_v{}^3\,[n\,(n+1)\,{}_{n-1}\sigma_u{}^2 - 3n\,(n-1)\,{}_{n-2}\sigma_u{}^2 + 3\,(n-1)\,(n-2)\,{}_{n-3}\sigma_u{}^2 \\
&\quad - (n-2)\,(n-3)\,{}_{n-4}\sigma_u{}^2 - 6\,(n-1)\,(2n-1)\,({}_{n-1}\bar{u} - {}_{n-2}\bar{u})^2 \\
&\quad + 6\,(n-1)\,(n-2)\,({}_{n-1}\bar{u} - {}_{n-3}\bar{u})^2 - 3\,(n-1)\,(n-2)\,({}_{n-2}\bar{u} - {}_{n-3}\bar{u})^2 \\
&\quad - (n-2)\,(n-3)\,({}_{n-1}\bar{u} - {}_{n-4}\bar{u})^2] + \ldots \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(xxiii)}.
\end{aligned}
$$

The convergence of these two series depends on the values of the coefficients of the successive powers of A_v; while these contain functions of n which increase as the size of the sample is increased, they also contain the differences of the first and second moments of the distribution of u, which steadily decrease. The following numerical values have been found for equations (xxii) and (xxiii):

$n = 6$

$$
\begin{aligned}
{}_6\bar{u}_v &= 1{\cdot}1630 + {\cdot}6679A_v + {\cdot}1729A_v{}^2 + {\cdot}1729A_v{}^3, \\
{}_6\sigma^2{}_{u_v} &= {\cdot}4475 - {\cdot}3101A_v + {\cdot}1254A_v{}^2 - {\cdot}1989A_v{}^3
\end{aligned}
$$

$n = 7$

$$
\begin{aligned}
{}_7\bar{u}_v &= 1{\cdot}2672 + {\cdot}6255A_v + {\cdot}1852A_v{}^2 + {\cdot}1481A_v{}^3, \\
{}_7\sigma^2{}_{u_v} &= {\cdot}4159 - {\cdot}2548A_v + {\cdot}0651A_v{}^2 - {\cdot}0859A_v{}^3.
\end{aligned}
$$

$n = 20$

$$
{}_{20}\bar{u}_v = 1{\cdot}844 + {\cdot}465A_v + {\cdot}184\,A_v{}^2 + {\cdot}12A_v{}^3.
$$

$n = 60$

$$
\begin{aligned}
{}_{60}\bar{u}_v &= 2{\cdot}313 + {\cdot}385A_v + {\cdot}16A_v{}^2, \\
{}_{60}\sigma^2{}_{u_v} &= {\cdot}2077 - {\cdot}065A_v + \ldots \text{ approximately.}
\end{aligned}
$$

$n = 100$

$$
\begin{aligned}
{}_{100}\bar{u}_v &= 2{\cdot}504 + {\cdot}360A_v + {\cdot}14A_v{}^2, \\
{}_{100}\sigma^2{}_{u_v} &= {\cdot}1848 - {\cdot}05A_v + \ldots \text{ approximately.}
\end{aligned}
$$

$n = 500$

$$
{}_{500}\bar{u}_v = 3{\cdot}036 + {\cdot}30A_v.
$$

For $n = 6$ the values of the mean and of the array standard deviation have been inserted in the last columns of Table III; it will be seen that as far as $v = 0$ or within the range $v = -\infty$ to $v = \bar{v} + 2\,{}_6\sigma_v$, four terms of the expansions give a very satisfactory fit to the true values of the regression and scedasticity. For larger samples we have only available complete tabled values of the means of the u distribution, with a few isolated values of σ_u*.

The coefficients in (xxii) contain 1st, 2nd and 3rd differences of ${}_n\bar{u}$, and these become so small that when we reach a sample of 500 it becomes impossible to ascertain even the coefficient of $A_v{}^2$. For the same reason we should not be able

* Tippett's Table X giving $\bar{w} = 2\bar{u}$, and his Table I giving σ_u at $n = 10, 20, 60, 100, 200, 500, 1000$.

to obtain sufficiently accurate values for the differences of ${}_n\sigma_u{}^2$ by interpolating in Tippett's Table I. Approximate values for the coefficient of A_v in the expansion of ${}_n\sigma_u{}^2$ have however been obtained for $n = 60$ and 100*. An examination of these equations suggests the following points :

(*a*) There is some irregularity for $n = 6$ and 7, but otherwise the numerical coefficients appear to decrease both within the series as the index of A_v increases, and from series to series as n increases.

TABLE V.

Regression and Scedasticity at Limits of Significant Frequency.

n		Values from Expansions in A_v of p. 185			Values on Assumptions of Linearity of Regression and Homoscedasticity	
		Asymptotic Limit	At $v = \bar{v} + 2\sigma$	At $v = \bar{v} + 3\sigma$	At $v = \bar{v} - 3\sigma$	At $v = \bar{v} + 3\sigma$
60	$\bar{u}_v$ σ_{u_v}	2·31 ·456	2·34 ·450	2·38 ·444	2·30 ·454	2·34 ·454
100	$\bar{u}_v$ σ_{u_v}	2·50+ ·430	2·52 ·427	2·55 ·423	2·50− ·429	2·52 ·429

(*b*) For $n = 60$ and 100, we have the comparisons of Table V. Assuming that the expansions of page 185 are adequate, we see that while the assumptions of linear regression and homoscedasticity are not strictly accurate, even in the range $\bar{v} \pm 3\sigma$, the error at the limit of significant frequency is now reduced to something of the order of $2°/_{\circ}$, while in the case of $n = 6$ it was of the order of $20°/_{\circ}$†. That is to say for samples of size 60 or more we can hardly be involved in any serious error in accepting Tippett's values for the constants β_1 and β_2 of the distribution of range, which have been based on the assumption of linear regression and homoscedasticity in the u, v surface. It remains therefore to bridge over the gap between $n = 6$ and $n = 60$. Figure 7 shows that this is rather a critical stretch of the $\beta_1\beta_2$ curve, because it is here that the skewness of the distribution of range after starting to decrease as n increases from 0 to 6 begins to increase.

Turning back to p. 179, we see that the values of p_{12} and p_{13} found for $n = 6$ on the assumption of linear regression are most unsatisfactory, particularly the former. Suppose that a parabola is fitted to the regression line by Least Squares or by the method of Orthogonal Functions‡, then to the second order its equation can be put in the form

$$\bar{u}_v - \bar{u} = r\,(v - \bar{v}) + \frac{p_{12} + \mu_2 r}{\mu_4\mu_2 - \mu_3{}^2 - \mu_2{}^3}\,\{(v - \bar{v})^2\,\mu_2 + (v - \bar{v})\,\mu_3 - \mu_2{}^2\} \ldots (\text{xxiv}),$$

* Obtained by fitting parabolae through ${}_{20}\sigma$, ${}_{60}\sigma$, ${}_{100}\sigma$, and ${}_{60}\sigma$, ${}_{100}\sigma$, ${}_{200}\sigma$ respectively.

† For $n = 6$, at $v = +0{\cdot}5 = \bar{v} + 2{\cdot}7\sigma$, the true values of $\bar{u}_v$ and σ_{u_v} are 1·81 and ·507 respectively, while for linear regression and homoscedasticity we should have 1·51 and ·639.

‡ *Biometrika*, Vol. XIII. p. 296 *et seq.*

where the momental constants μ_2, μ_3, μ_4 are those for the distribution of u (e.g. ${}_u\mu_2 = -{}_v\mu_3$). Now at $n = 10$, 20, 60, etc., all the constants in this equation are known except p_{12}; if then we can find by some other method the equation to the second order parabola "best fitting" the regression line in these cases, we shall be able to determine the values of p_{12}, whether such a curve gives an adequate description of the regression line or not.

The parabola of (xxiv) cuts the regression straight line

$$\tilde{u}_v - \bar{u} = r(v - \bar{v}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(xxv)},$$

where
$$(v - \bar{v})^2 \mu_2 + (v - \bar{v})\mu_3 - \mu_2^2 = 0,$$

or
$$v = \bar{v} + \tfrac{1}{2}\{-\sqrt{\beta_1} \pm \sqrt{\beta_1 + 4}\}\ \sigma_v^* \ldots\ldots\ldots\ldots\ldots\ldots\text{(xxvi)}.$$

But these two points are known for $n = 10$, 20, 60, etc., and it is therefore only necessary to fix one other point on the parabola to determine its equation. For $n = 6$ the equation to the regression parabola given by (xxiv) is

$$\tilde{u}_v = 1{\cdot}544\ 571 + {\cdot}334\ 276v + {\cdot}072\ 329v^2 \ \ldots\ldots\ldots\ldots\text{(xxvii)},$$

ordinates of which are given in Table III; they will be seen to correspond closely with the true regression points in the central region only. The vertex of this parabola is at

$$\left.\begin{aligned} v &= -2{\cdot}311 = {}_6\bar{v} - 1{\cdot}618\ {}_6\sigma_v \\ u &= 1{\cdot}158 \end{aligned}\right\},$$

which is slightly below the true asymptote

$$u = {}_{n-1}\bar{u} = 1{\cdot}163.$$

The vertices of the regression parabolae for $n = 2$, 3, 4, 5 are found to lie at

$$\begin{aligned} n = 2, &\quad v = -2{\cdot}581 = {}_2\bar{v} - 2{\cdot}443\ {}_2\sigma_v, \\ n = 3, &\quad v = -2{\cdot}252 = {}_3\bar{v} - 1{\cdot}879\ {}_3\sigma_v, \\ n = 4, &\quad v = -2{\cdot}235 = {}_4\bar{v} - 1{\cdot}720\ {}_4\sigma_v, \\ n = 5, &\quad v = -2{\cdot}268 = {}_5\bar{v} - 1{\cdot}652\ {}_5\sigma_v. \end{aligned}$$

These values suggest that as n increases the vertex of the regression parabola will lie at a point about $1{\cdot}6\ {}_n\sigma_v$ to the left (in the sense of Fig. 4) of the mean of the margin (${}_n\bar{v}$). We cannot of course be sure that the multipliers of ${}_n\sigma_v$, as shown above, will continue to converge on $-1{\cdot}6$, but some form of extrapolation is necessary at this stage and this appears a reasonable hypothesis†. Giving the regression parabolae vertices at points with $v = {}_n\bar{v} - 1{\cdot}6\ {}_n\sigma_v$ and making them pass through the two known points of (xxvi), I have calculated their equations, which are as follows:

$$\begin{aligned} n = \ 10, &\quad {}_{10}\bar{u}_v = 1{\cdot}7728 + {\cdot}2361v + {\cdot}04764v^2, \\ n = \ 20, &\quad {}_{20}\bar{u}_v = 2{\cdot}0327 + {\cdot}1413v + {\cdot}0261v^2, \\ n = \ 60, &\quad {}_{60}\bar{u}_v = 2{\cdot}4066 + {\cdot}0622v + {\cdot}0102v^2, \\ n = 100, &\quad {}_{100}\bar{u}_v = 2{\cdot}5688 + {\cdot}0409v + {\cdot}0064v^2. \end{aligned}$$

* β_1 is for the u distribution, i.e. $\sqrt{{}_u\beta_1} = -\sqrt{{}_v\beta_1}$. Of course $\sigma_u = \sigma_v$.

† Slight variations in the position chosen for the vertex of the parabola do not make a very serious difference to the resulting value calculated for ${}_w\beta_1$. E.g. for $n = 20$ if vertex is at

$$v = {}_n\bar{v} - 1{\cdot}5\ {}_n\sigma_v, \text{ then } {}_w\beta_1 = {\cdot}165,$$

and at $v = {}_n\bar{v} - 1{\cdot}7\ {}_n\sigma_v$, then ${}_w\beta_1 = {\cdot}157$.

Assuming these equations to correspond very closely to the " best fitting " regression parabolae, we obtain the following values of p_{12} and ${}_w\beta_1$, which are compared in the last two columns with the results given by Tippett in his Table IV.

TABLE VI. *Values for β_1 of Range.*

n	p_{12}	${}_w\beta_1$	${}_w\beta_1$ (if r were zero)	${}_w\beta_1$ (if regression linear)
10	·00576	·156	·084	·063
20	·00172	·161	·125	·111
60	·00031	·201	·188	·181
100	·00014	·223	·215	·210
200	—	·247	as in preceding column	

Various other methods of estimating ${}_w\beta_1$ were considered, but it is believed that the values given in the third column of Table VI are the most satisfactory that can be obtained without the very great labour of direct computation. It seems unlikely that they can be more than 2 or 3 °/₀ in error and they connect up satisfactorily the known values for $n = 2$ to 6, with those given by Tippett for large samples where the assumption of linear regression is certainly justified. Figure 5 shows graphically the relation between these different values of ${}_w\beta_1$ in the interval $n = 2$ to 20.

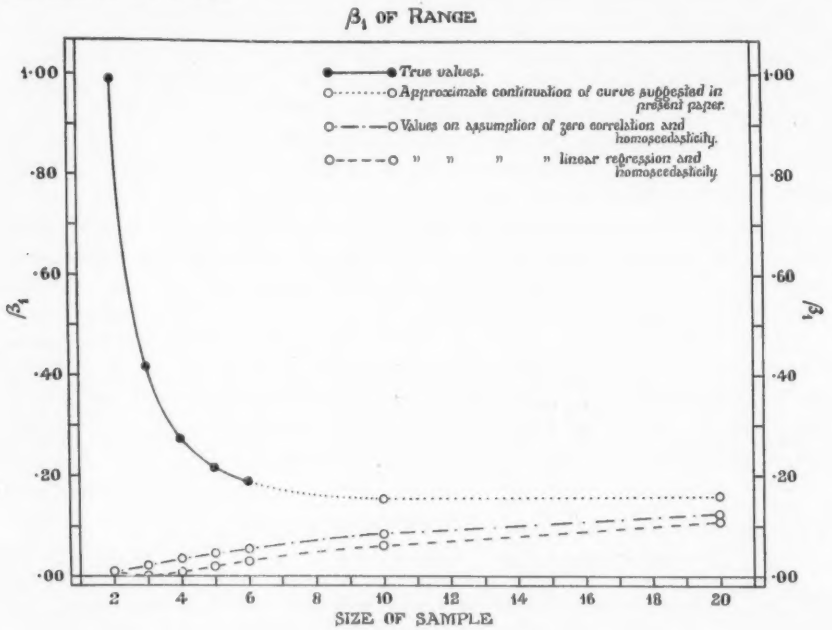


Fig. 5.

The value of ${}_w\beta_2$ depends on that of ${}_w\mu_4$ and for this we require p_{13} and p_{22}. If a second order parabola gave an adequate description of the regression line, it can be shown that

$$p_{13} = r\mu_4 + \frac{p_{12} + r\mu_3}{\mu_4\mu_2 - \mu_3^2 - \mu_2^3}\mu_3\mu_2^2\left\{-\frac{\beta_3}{\beta_1} + \beta_2 + 1\right\}^* \ldots\ldots\ldots(\text{xxviii}).$$

In the case of $n = 6$, this leads to

$$p_{13} = \cdot 075\ 781 - \cdot 017\ 469 = \cdot 058\ 312,$$

whereas the true value is $\cdot 067\ 983$; that is to say the correction to the value obtained on the assumption of linear regression is in the right direction but double the required amount. In fact for $n = 10$, 20, etc. we cannot hope to obtain a satisfactory value for p_{13} from the second order regression parabolae of p. 187; for they do not adequately represent the regression. Now p_{13} could be obtained from the "best fitting" cubic regression line which could be determined to pass through 3 points on the known regression straight line, and to touch the asymptote $u = {}_{n-1}\bar{u}$. Again an improved value for p_{22} could be obtained by using $\eta^2_{u_v}$ in the third equation of (xvi) and by applying some correction for scedasticity, but when it is remembered that the basic constants on which we should need to build up this

TABLE VII.

Values for β_2 of Range.

n	${}_w\beta_2$	${}_w\beta_2$ (if r were zero)	${}_w\beta_2$ (if regression linear)
10	3·22	3·17	3·14
20	3·26	3·23	3·22
60	3·35	3·34	3·33
100	3·39	3·38	3·38
200	3·44	as in preceding column	

corrective superstructure (σ_u, ${}_u\beta_1$ and ${}_u\beta_2$ of Tippett's Table I) are known to only 3 or at most 4 significant figures, it seems very doubtful whether the final results so obtained would be at all reliable. After trying various cruder methods of approximation, the following values of ${}_w\beta_2$ are therefore suggested as probably lying within 1 or 2% of the true values. They are again compared with Tippett's values, and the whole represented graphically in Figure 6.

As in the case of Figure 5 it is seen how the approximate curves approach the curve of more accurate values from below, the assumption of zero correlation giving slightly more satisfactory results than that of linear regression. No importance can, I think, be attached to this fact; below $n = 20$ neither assumption can be justified, but the combination of several inaccurate terms in equations (i) are such

* Again as in (xxiv) the momental constants are for the u distribution and $\beta_3 = \frac{\mu_5\mu_3}{\mu_2^4}$, and can be obtained approximately by assuming that this distribution follows a Pearson Type curve, when

$$\beta_3 = \frac{2\beta_1(\beta_2^2 + 7\beta_2 - 3\beta_1)}{9 + 3\beta_1 - \beta_2}.$$

as to cause the former to give to the ratios ${}_w\beta_1$ and ${}_w\beta_2$ values nearer the truth than the latter.

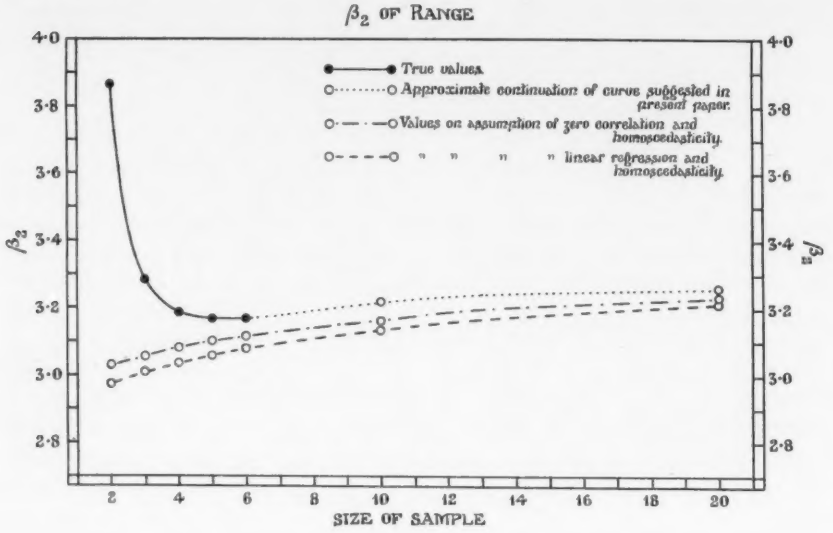


Fig. 6.

Figure 7 is a diagram of the $\beta_1\beta_2$ field, showing the resulting curve followed by the point ${}_w\beta_1$, ${}_w\beta_2$ as n increases; the less certain portion between $n = 6$ and 100 is dotted. The diagram also contains the curve for ${}_u\beta_1$, ${}_u\beta_2$, or the constants of the distribution of the largest individual in the sample.

The peculiar forms of these curves deserve perhaps special consideration. Taking first that for the distribution of u, the largest individual, we start with the case of a sample of one where the distribution is simply that of the original normal population; then as n increases the corresponding β_1, β_2 point moves at a decreasing rate along a curve which lies first in the Type IV and later the Type VI area*. The physical interpretation of this increasing skewness would seem to be as follows. For a given size of sample there is a certain modal value of u; above this modal value u may take freely any of the population values extending towards $+\infty$; but below it, the range becomes more and more restricted as n increases and there are more and more individuals in the sample whose values must lie below u. Thus the distribution of u is skew, and positively skew with the steeper slope on the side corresponding to the lower values of the character. The distribution of v, the lowest individual, is identical but with negative skewness.

* Strictly u may lie anywhere between $+\infty$ and $-\infty$, but the larger the sample the greater becomes the improbability of u taking large negative values. This tendency is reflected in the $\beta_1\beta_2$ diagram by the curve passing near $n = 10$ from the Type IV area (unlimited in both directions) to the Type VI area (limited in one direction).

DIAGRAM SHOWING THE β_1, β_2 POINTS CORRESPONDING TO THE FREQUENCY DISTRIBUTIONS OF THE EXTREME INDIVIDUAL (u or v) & THE RANGE (ω) IN SAMPLES OF 12

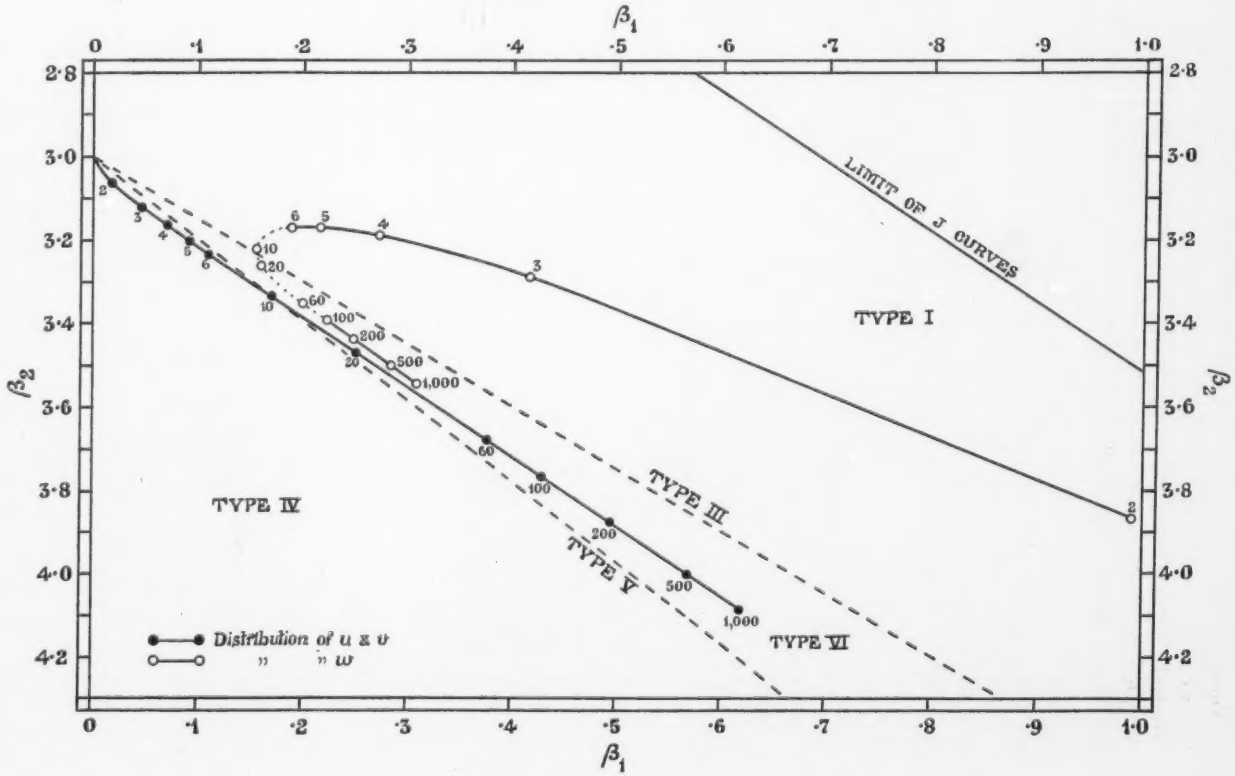


Fig. 7.

Turning to the range, w, in the sample we start with the case of two individuals only, when the distribution is half a normal curve with a precipitous end at $w=0$. This half curve cannot of course be represented exactly by a complete Pearson curve, but the curve most closely representing it would be very skew ($\beta_1 = \cdot 9906$, $\beta_2 = 3 \cdot 8692$, without corrections for abruptness). For a sample of three, the modal value of w will still be low, lying near the limiting value of 0, but the curve is far less skew ($\beta_1 = \cdot 4174$, $\beta_2 = 3 \cdot 2864$). The skewness decreases until n is in the neighbourhood of 10. This stretch of the curve corresponds to that in which there is a correlation between the highest and lowest individuals in the sample. The backward bend of the curve comes at the transition period when the influence of the position of v on that of u is vanishing. When they are effectively independent, we reach the stretch of curve from $n=100$ to 1000 and beyond, which follows closely the curve for the distribution of u. Here there is no upper limit to the range but an increasingly sharply defined lower limit resulting from the fact that more and more observations have to be fitted into the space between u and v as n increases. This again implies positive skewness, and the appropriate curve is a Type VI with a limiting range on the lower side, but extending to infinity in the direction of increasing range. We have from equations (i) and (ii), as a very close approximation,

$$ {}_w\beta_1 = \tfrac{1}{2}\, {}_u\beta_1, \quad {}_w\beta_2 = \tfrac{1}{2}\, {}_u\beta_2 + 1 \cdot 5. $$

In any particular problem where the distribution of range is required, a worker may proceed as follows:

Mean; values to be taken from Table X at the end of Tippett's paper.

Standard Deviation; for large samples use Tippett's Diagram VI or for n less than 20, Figure 2 of the present paper.

${}_w\beta_1$ *and* ${}_w\beta_2$; for $n = 200$ or more, use Diagrams VII and VIII of Tippett's paper; otherwise Figures 5, 6, or 7 of this paper.

TABLE VIII.

Summary of Constants of Distribution of Range.

n	Mean	Standard Deviation	β_1	β_2
2	1·12838	·8525	·9906	3·8692
3	1·69257	·8884	·4174	3·2864
4	2·05875	·8798	·2735	3·1884
5	2·32593	·8641	·2167	3·1693
6	2·53441	·8480	·1892	3·1698
10	3·07751	·797	·156	3·22
20	3·73495	·729	·161	3·26
60	4·63856	·639	·201	3·35
100	5·01519	·605	·223	3·39
200	5·49209	·566	·247	3·44
500	6·07340	·524	·285	3·50
1000	6·48287	·497	·309	3·54

As the results are somewhat scattered, it is perhaps desirable to put together a framework of values in one table. These are given in Table VIII (p. 192). It is hoped that the present paper will have cleared up certain points left doubtful in the earlier work; but at the same time the writer wishes to make it clear that he has had the easier task, and that it would have been impossible for him to bridge over the gap of medium sized samples without the heavy spadework which Mr Tippett carried out in computing the values of the means and standard deviations of range. The diagrams are as usual the excellent work of Miss Ida McLearn.

Note on the Relation between $\overline{w}_n$ and $\chi_{n,p}$.

In the notation of the preceding paper, and of Irwin's paper on "Francis Galton's Individual Difference Problem*," we may write, in samples of n drawn at random from a normal population, $\overline{w}_n$ = mean range; $\chi_{n,p}$ = mean difference between the characters of the pth and $(p+1)$th individuals when the sample is arranged in the order of magnitude of the characters.

The existence of the following general relation,

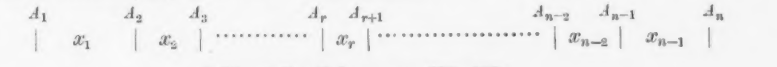
$$\chi_{n,p} = \tfrac{1}{2}\frac{n!}{p!\,n-p!}(-1)^{p+1}\Delta^p\overline{w}_{n-p} \quad \text{.....(i)},$$

between $\chi_{n,p}$ and the forward differences of $\overline{w}_{n-p}$ has been recently indicated to me by "Student," who was able to prove that it held true for $p = 1$, 2 and 3, and also to obtain numerical confirmation by using the special values of $\chi_{n,p}$ given by Irwin (*loc. cit.* p. 107), and the series of tabled values of $\overline{w}_n$ given by Tippett†. Given a complete table of ranges, this equation should enable one to obtain any desired value of $\chi_{n,p}$, but in practice its use will be limited to fairly low values of n by the fact that the differences of $\overline{w}_n$ decrease very rapidly. For example, taking Tippett's table of $\overline{w}_n$, which is calculated to 5 decimal places, it is found that $\Delta^3\overline{w}_n$ has practically vanished by the time that $n = 40$. On the other hand, for a sample of 10, we can obtain the following series of values of $\chi_{10,p}$, which have errors of not more than one unit in the third decimal place:

$p=$	1	2	3	4	5	6	7	8	9
	·537	·345	·280	·256	·237	·256	·280	·345	·537

These give a total range of 3·073 against the true $\overline{w}_{10} = 3{\cdot}07751$.

A general proof of equation (i) may be obtained as follows. If we draw repeated samples of n from the population, these will give a representative distribution of samples of $n-s$ supposing that in each case the first s individuals in the draw are excluded. Denote by λ the constitution of a sample of n with a particular set of character values for the n individuals, and suppose that the chance of obtaining λ is p_λ. The distribution λ may be represented diagrammatically as follows, the n observations lying at $A_1, A_2, \ldots A_n$ as below:



* *Biometrika*, Vol. XVII. pp. 100—128.

† *Biometrika*, Vol. XVII. Table X, pp. 386—387.

being placed in order of character value; x_1, x_2, ... x_{n-1} are the distances between successive values. The s first drawn individuals will be distributed in a random manner among the A's. For the sample of n, we have the range

$$_\lambda w_n = x_1 + x_2 + \ldots + x_{n-1}.$$

For the sample of $n-s$, the range will be short by at least x_1 whenever one of the s individuals lies at A_1; the chance of this happening is s/n. Similarly the range will be short by at least x_{n-1} whenever one of the s individuals lies at A_n; the chance of this is also s/n.

The range will be short by at least $x_1 + x_2$ whenever two of the s individuals lie one at A_1 and one at A_2; the chance of this occurring is $s(s-1)/n(n-1)$. This is also the chance of the range being short by at least $x_{n-2} + x_{n-1}$.

In general the range for the sample of $n-s$ will be short of the range for a sample of n by an amount which includes x_r, whenever the positions $A_1, A_2, A_3, \ldots A_r$ are all occupied by r of the s first drawn individuals; the chance of this occurring is

$$\frac{s(s-1)\ldots(s-r+1)}{n(n-1)\ldots(n-r+1)}.$$

When none of the s lie at either A_1 or A_n, the range in the sample of $n-s$ is the same as in the sample of n. Now taking all possible constitutions, λ, of samples of n, and remembering that p_λ is quite independent of the distribution of the s individuals among the points A_1, ... A_n, we find for the mean range

$$\overline{w}_n = \overline{w}_{n-s} + \frac{s}{n}(\bar{x}_1 + \bar{x}_{n-1}) + \frac{s(s-1)}{n(n-1)}(\bar{x}_2 + \bar{x}_{n-2}) + \frac{s(s-1)(s-2)}{n(n-1)(n-2)}(\bar{x}_3 + \bar{x}_{n-3})$$
$$+ \ldots + \frac{s(s-1)\ldots\ldots 1}{n(n-1)\ldots(n-s+1)}(\bar{x}_s + \bar{x}_{n-s}) \quad \ldots\ldots\ldots\ldots\text{(ii)}.$$

This relation holds because, in order to make up w_n, w_{n-s} must be supplemented

(1) by x_1 on every occasion when A_1, the extreme, is occupied by one of the s first drawn individuals;

(2) by x_2 in addition whenever A_2, the second place, is occupied as well as the first;

(3) by x_3 also, whenever A_1, A_2 and A_3 are all occupied, etc. etc.

Hence remembering that $\bar{x}_r = \bar{x}_{n-r} = \chi_{n,r}$, we have

$$\overline{w}_n = \overline{w}_{n-s} + 2\frac{s}{n}\chi_{n,1} + 2\frac{s(s-1)}{n(n-1)}\chi_{n,2} + \ldots + \frac{2(s!)}{n(n-1)\ldots(n-s+1)}\chi_{n,s} \quad \ldots \text{(iii)}.$$

If now we take the p equations obtained by putting s equal successively to $p, p-1, \ldots 3, 2, 1$, we may eliminate all the χ's except $\chi_{n,p}$ by taking p differences, and have finally

$$0 = \Delta^p \overline{w}_{n-p} + (-1)^p \frac{2(p!)}{n(n-1)\ldots(n-p+1)}\chi_{n,p},$$

or

$$\chi_{n,p} = \tfrac{1}{2}\frac{n!}{p!\,n-p!}(-1)^{p+1}\Delta^p \overline{w}_{n-p} \quad \ldots\ldots\ldots\ldots\text{(i) bis.}$$

If n be odd this relation holds for all values of p between 1 and $\frac{1}{2}(n-1)$; if even from $p=1$ to $\frac{1}{2}n$.

ON THE CORRELATION OF HEAD MEASUREMENTS AND MENTAL AGILITY. WOMEN.

By J. R. MUSSELMAN, Ph.D., Johns Hopkins University.

The question as to the correlation of head measurements and intelligence has been discussed before. Observations would appear to give somewhat conflicting results; all those of the Biometric Laboratory* show only the smallest correlation between intelligence and head shape or size. Other investigators, especially in Germany, without using any adequate correlation method have asserted there is such a relation. It is not denied there may be some association; the problem is to find the intensity of that relationship, and without a measure of this intensity any such assertions are of little value. The biometricians have not denied some association but have asserted it is so small that it can be of no prognostic value.

It seemed worth while to consider whether on the data of Francis Galton's Second Anthropometric Laboratory Series any relation could be found between head size or shape and mental agility, as represented by reaction times to sight and sound.

The data for women in Francis Galton's Second Series cover about 1850 individuals between the ages of 3 and 76. At that time (1880–90) measurements were taken in inches, so the tables and computations were made in that unit and the final results then expressed in millimetres. At the beginning of his series the head lengths were measured from the nasion to the occipital point, consequently these have been discarded and I have taken only the data for head lengths from glabella to occipital point which cover about 1700 individuals. It is necessary to correct both the head lengths and head breadths for age. Diagrams I and II (pp. 197–8) show the curves of means for lengths and breadths by years. Above the age 53 the curves are dotted as the number of individuals is relatively small in these age groups and it appears that we have mostly large-headed women in them†. Consequently this part of the curve does not portray wider actual experience as well as it might. On the same diagrams are plotted the standard deviations by years. The total numbers in the age groups are too small to make any correction for the standard deviation of arrays of real service. The average results appear to be adequately represented by a horizontal straight line. We find that the mean head breadth of 1852 women is 145·68 mm., and the mean head length of 1693 women is 184·38 mm.; with 4·855 mm. and 6·232 mm. as standard deviations respectively.

* See especially *Biometrika*, Vol. v. p. 105 *et seq.*

† It is possible that a certain amount of vanity in size of head led to a selection of the larger-headed old ladies; or the curves may suggest that the head does continue to grow till extreme old age.

The following comparison of head measurements before and after correction to a standard age of 40·5 years may be of interest:

Character	Before Correction for Age			After Correction for Age		
	Mean	Standard Deviation	Coefficient of Variation	Mean	Standard Deviation	Coefficient of Variation
Breadth ...	145·68 mm.	4·855 mm.	3·33	146·19 mm.	4·667 mm.	3·19
Length... ...	184·38 mm.	6·232 mm.	3·38	184·97 mm.	5·923 mm.	3·20
Cephalic Index	79·07	3·036	—	[79·03*]	—	—

The raising of the means may be naturally expected as the mean value at 40·5 years is greater than that of earlier years which contain the bulk of the material. It would be still greater had childhood been more heavily represented. The slightly decreased variability is also to be expected, as the variability at a given age must be less than the total variability for all ages. As the standard deviations of the arrays have been treated as sensibly constant (see Diagrams I and II) the reduction to age 40·5 as standard was simple, the deviation plus or minus of any individual from the mean of his age was merely added or subtracted from the mean of age 40·5 for the same character.

For those women for whom head breadths were available (1834 and 1835) we have for reaction times the following values:

Reaction Times in Women in $\frac{1}{100}$'s of a second.

	Mean	Standard Deviation	Coefficient of Variation
Reaction Time to Sound	15·822	3·1962	20·20
" " Sight	19·350	3·6796	19·02

It is clear accordingly that there is much variability in reaction time, that to sight being absolutely greater, but relatively less than that to sound.

Tables I and II give the data from which Diagrams I and II were made. Table III (p. 199) gives in inches and millimetres the head breadth and head length by ages as read from the curve fitted by aid of a spline to the means. As it seems improbable that the large-headed women in later ages are in all these cases (30 in all) a true sample of existent population for ages above 53, the same head length and head breadth reductions were used. Table IV (p. 200) gives the standard deviations by years of the head breadths and head lengths in inches and millimetres; from these data the upper series of points on Diagrams I and II were plotted.

* Ratio of corrected means, showing cephalic index needs no correction for age.

Head Breadth in Inches. Central Values.

	5·73	8	10	11·5	12·5	13·5	14·5	15·5	16·5	17·5	18·5	19·5	20·5	21·5	22·5	23·5
5·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5·1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5·2	—	2	1	—	—	1·5	—	—	—	2	—	—	—	—	1	1
5·3	4	1	2·5	3	2·5	2	1	—	3	1·5	1·5	·5	—	1	·5	1
5·4	2	4·5	4	1·5	5	·5	1	1	2·5	2·5	1	5·5	4·5	2	4	4·5
5·5	4	5	5·5	5	5·5	9·5	3	6·5	7·5	11·5	6·5	9	10·5	13·5	8	7
5·6	1	4	5·5	9·5	7	10	7·5	9·5	13·5	13·5	11·5	11·5	18	14·5	18·5	13
5·7	1	1·5	10	5	10	8	12·5	6	20	20·5	25·5	24	21	18·5	27	22
5·8	1	2·5	3	—	6	4	6·5	18·5	10·5	10	14	21	18	24	18	16
5·9	—	1·5	3·5	1	5	3·5	6	5·5	10·5	10·5	13	18·5	18·5	16	14·5	24
6·0	—	—	—	1	2	4	3·5	1·5	4·5	5	5·5	11	9·5	5·5	6·5	2·5
6·1	—	—	—	1	—	—	—	1·5	4·5	1	2	2·5	3	1	1	1
6·2	—	—	—	—	—	—	—	—	·5	—	·5	2	—	—	1	2
6·3	—	—	—	—	—	—	—	—	—	—	1	·5	—	—	1	—
6·4	—	—	—	—	—	—	—	·5	—	—	—	—	—	—	—	—
6·5	—	—	—	—	—	—	—	·5	—	—	—	—	—	—	—	—
6·6	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—
6·7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6·8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals	13	22	35	27	44	43	42	51	77	78	82	106	103	96	101	94

Mean Head Breadth 5·736 inches or 145·6

Head Length in Inches. Central Values.

	5·73	8	10	11·5	12·5	13·5	14·5	15·5	16·5	17·5	18·5	19·5	20·5	21·5	22·5	23·5
6·4	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—
6·5	—	1·5	—	1	—	—	—	1	—	—	—	1	—	—	—	—
6·6	1	1·5	·5	—	—	1	—	—	—	—	—	—	—	1	—	—
6·7	4	1	·5	1	—	—	—	—	3	1	—	1	1	—	·5	2
6·8	2	1	3	2·5	1	—	2	2	2·5	1	1·5	3	1	1·5	2·5	—
6·9	1	5·5	3·5	1	1	3·5	·5	·5	4·5	2	6·5	1·5	2	4·5	6	4
7·0	1·5	3	11·5	3·5	4	6·5	3·5	8	4·5	6·5	7·5	8	7	7·5	9·5	7
7·1	1·5	1·5	3·5	4·5	10·5	8·5	9	5	7·5	8·5	6·5	13	13	9·5	15	9
7·2	1	3	5	4·5	9·5	7·5	10·5	5	16	10·5	9	12·5	16	20	17	17
7·3	—	2	3·5	1·5	6	4·5	4	13	8	15	8·5	19·5	20·5	13·5	9·5	19
7·4	—	1	1	2·5	3	5·5	5	8	8·5	12·5	14	10·5	9·5	11	10	11
7·5	—	—	1	3	3·5	2·5	1·5	1·5	7	3·5	11·5	8·5	9	10	7	7
7·6	—	—	—	—	2·5	2	1	2	4·5	3·5	5·5	3·5	2·5	3·5	5·5	5
7·7	—	—	—	—	—	·5	2	—	1	3	2·5	6	5·5	3	·5	1
7·8	—	—	—	—	—	—	1	—	1	—	—	6·5	·5	1	—	—
7·9	—	—	—	—	—	—	—	—	·5	—	—	·5	·5	1	—	1
8·0	—	—	—	—	—	—	—	—	·5	—	1	—	—	1	1	—
8·1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
8·2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8·3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals	12	21	34	26	41	42	40	46	69	67	74	95	88	88	84	86

Mean Head Length 7·259 inches or 184·38

TABLE I.

Anthropometric Data, Second Laboratory Series, Females. Head Breadth and Age.

Central Ages in Years.

	20·5	21·5	22·5	23·5	24·5	25·5	26·5	27·5	28·5	29·5	30·5	31·5	32·5	33·5	34·5	35·5	36·5	37·5	39	41
	—	—	—	—	·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	1	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
	—	1	·5	1	3	—	2	—	—	—	—	—	—	—	—	·5	1	—	—	—
	4·5	2	4	4·5	2	3	3	2	·5	1·5	1	1·5	1	2	—	1·5	—	—	1	—
	10·5	13·5	8	7	6·5	12	7	6·5	4·5	3·5	7·5	2	2	5	—	2	·5	2·5	2	2
	18	14·5	18·5	13	17·5	11	5	4	8	6	10·5	5	6	3	5	1·5	8·5	2·5	4	4
	21	18·5	27	22	11·5	15·5	12	12·5	15	15	11	9·5	4	5·5	5	7	4	5	6	7·5
	18	24	18	16	12·5	11·5	14	10	15	8·5	7	6	4	4·5	6·5	4·5	4·5	6·5	7·5	10·5
	18·5	16	14·5	24	16·5	11	13	8	8	3·5	8·5	8·5	4	5·5	6·5	5	·5	5	6·5	11·5
	9·5	5·5	6·5	2·5	12·5	9	3	8	4	3	5	5·5	3·5	2·5	3	1·5	—	3	4·5	3
	3	1	1	1	4·5	3	—	2	4	—	·5	1	·5	—	2	2·5	—	·5	·5	1·5
	—	—	1	2	·5	1	2	—	1	—	—	—	—	—	—	—	—	—	—	1
	—	—	1	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
	103	96	101	94	88	78	61	54	60	41	53	39	25	28	29	26	19	25	32	41

…dth 5·736 inches or 145·68 mm. Standard Deviation ·1911 inches or 4·8549 mm.

TABLE II.

…n's Anthropometric Data, Second Laboratory Series, Females. Head Length and Age.

Central Ages in Years.

	20·5	21·5	22·5	23·5	24·5	25·5	26·5	27·5	28·5	29·5	30·5	31·5	32·5	33·5	34·5	35·5	36·5	37·5	39	41
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
	—	1	—	—	—	·5	—	—	·5	—	—	—	—	—	—	—	—	—	—	—
	1	—	·5	2	1	·5	·5	1	·5	—	—	1	1	—	—	—	—	—	—	—
	1	1·5	2·5	—	3	·5	·5	2	2	·5	—	—	1	—	2	1	1	3	1	1
5	2	4·5	6	4	3·5	1·5	2	2·5	1	2·5	5	3	2	2	2	2	1	—	—	1
	7	7·5	9·5	7·5	7·5	11	3	4	1	3·5	3·5	1	1	4·5	1	—	1	1·5	1	4
	13	9·5	15	9	11·5	7·5	8·5	2	9	4·5	4	4	3·5	4	3·5	2	2·5	1·5	2·5	7·5
5	16	20	17	17	13	14	7·5	7·5	8	6·5	7	9·5	6	1·5	4	5	3	2	6	7·5
5	20·5	13·5	9·5	19	13	9·5	12·5	12	10·5	5·5	6·5	7·5	2·5	4	1·5	5·5	4·5	5	11	7
5	9·5	11	10	11·5	15·5	12	7·5	5·5	7	9	9·5	4	3·5	4	7	3·5	1·5	5·5	6	6
5	9	10	7	7	4	3·5	3·5	2·5	8·5	3	4·5	4·5	3·5	2	2	3	3·5	3	·5	1
5	2·5	3·5	5·5	5	4	5·5	3·5	2·5	4	3	5	2	1	1·5	1	2·5	—	1·5	3	3·5
	5·5	3	·5	1	4	—	4	1·5	3	1	1·5	·5	—	1	—	·5	—	2	—	1
5	·5	1	—	—	—	3	—	—	2	1	·5	—	—	2·5	2	—	—	—	—	·5
5	·5	1	—	1	2	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—
	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	88	88	84	86	82	69	53	44	57	40	48	37	25	27	27	25	18	25	31	40

…th 7·259 inches or 184·38 mm. Standard Deviation ·2454 inches or 6·2320 mm.

37·5	39	41	43	45	47	49·5	52·5	55·5	59·5	67·63	Totals
—	—	—	—	—	—	—	—	—	—	—	·5
—	—	—	—	—	—	—	—	—	—	—	·5
—	—	—	—	—	—	—	—	—	—	—	9·5
—	—	—	1	—	—	—	—	—	—	—	32·5
—	1	—	1	2	·5	—	—	—	—	—	69·5
2·5	2	2	1	4	3·5	1	—	—	—	—	192·5
2·5	4	4	4·5	1·5	4·5	·5	2·5	3·5	—	—	286·5
5	6	7·5	5	4	5·5	4	3·5	4	1	—	405·5
6·5	7·5	10·5	7	3·5	5·5	5·5	3·5	2·5	2·5	1	337
5	6·5	11·5	3·5	4	2·5	4·5	4	1·5	·5	2	295·5
3	4·5	3	4	2	1	1·5	2·5	3·5	2	3	152·5
·5	·5	1·5	—	—	—	—	1	—	1	1	44
—	—	1	1	—	—	—	—	—	—	1	13·5
—	—	—	—	·5	1	—	1	—	—	—	7
—	—	—	—	·5	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	·5
—	—	—	—	—	—	—	—	—	—	—	2
—	—	—	—	—	—	—	—	—	—	—	1
—	—	—	—	—	—	—	—	—	—	—	0
—	—	—	—	—	—	—	—	—	—	—	1
25	32	41	28	22	24	17	18	15	7	8	1852

mm.

e.

37·5	39	41	43	45	47	49·5	52·5	55·5	59·5	67·63	Totals
—	—	—	—	—	—	—	—	—	—	—	2
—	—	—	—	—	—	—	—	—	—	—	5·5
—	—	—	—	—	—	—	—	—	—	—	6
—	—	—	—	—	—	—	—	—	—	—	20·5
3	1	1	1	—	1	—	—	—	—	—	47
—	—	1	1	—	—	—	1	—	—	—	80·5
1·5	1	4	4·5	2	3	1	—	—	—	—	158·5
1·5	2·5	7·5	1·5	2	2·5	1	2	—	—	1	214
2	6	7·5	4	1·5	6·5	3	3	2	—	1	293
5	11	7	4	4·5	4·5	2·5	1·5	·5	—	1	284·5
5·5	6	6	3	4	·5	3·5	3·5	1·5	1	—	237·5
3	·5	1	4	3	1	4	3·5	2·5	2·5	1	150·5
1·5	3	3·5	—	2	1	—	·5	5	2	2·5	97·5
2	—	1	3	—	1	1	—	·5	·5	1·5	52·5
—	—	·5	1	—	—	—	1	1	—	—	24·5
—	—	—	—	—	1	—	1	2	—	—	11·5
—	—	—	—	—	·5	—	—	—	—	—	4
—	—	—	—	—	·5	—	—	—	—	—	2·5
—	—	—	—	—	—	—	—	—	·5	—	·5
—	—	—	—	—	—	—	—	—	·5	—	·5
25	31	40	27	19	23	16	17	15	7	8	1693

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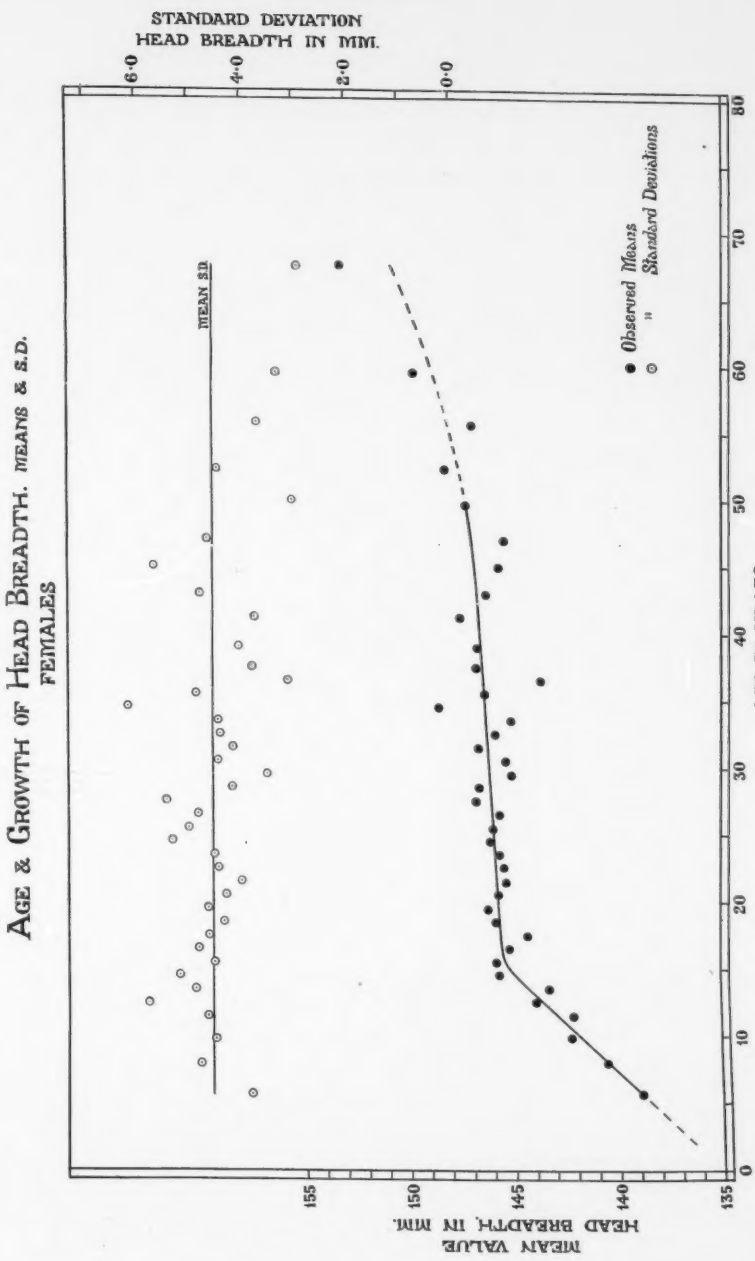
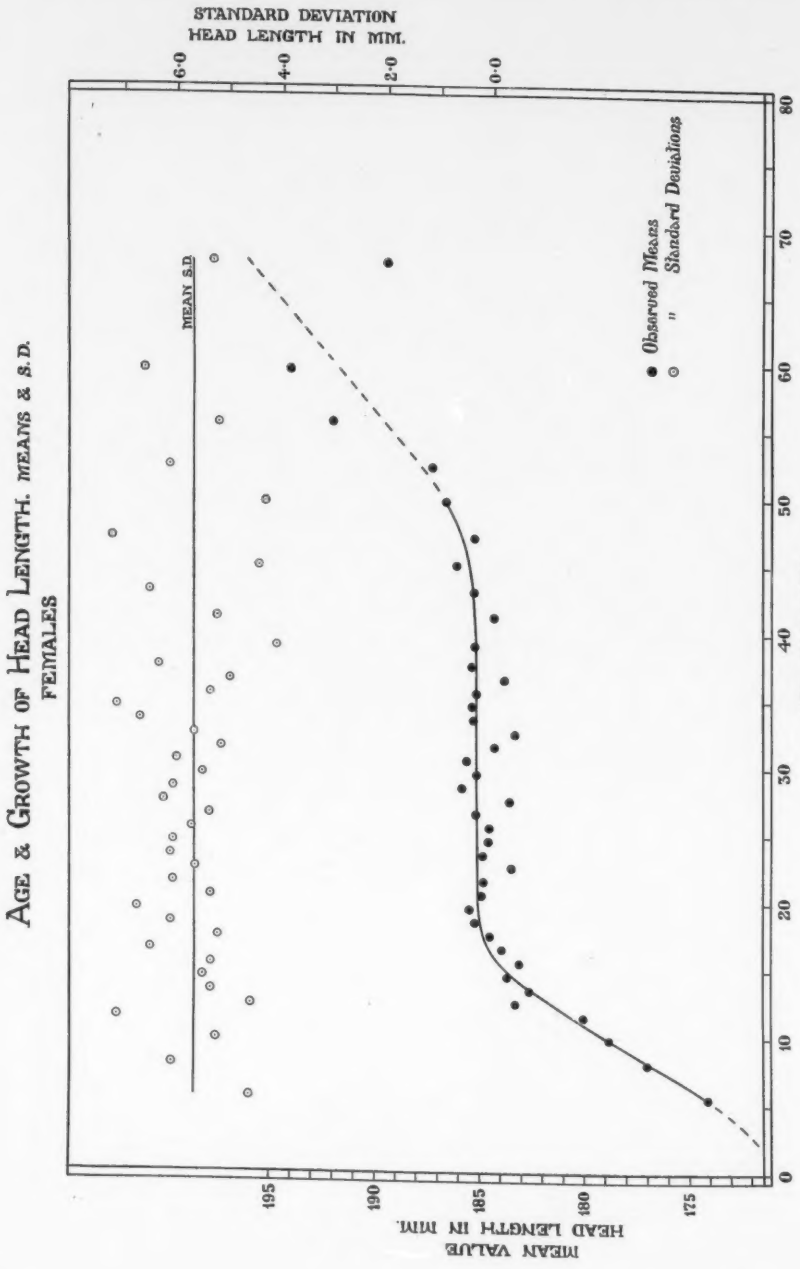


AGE & GROWTH OF HEAD BREADTH. MEANS & S.D.
FEMALES

Diagram I.



AGE & GROWTH OF HEAD LENGTH. MEANS & S.D.
FEMALES

Diagram II.

TABLE III.

Head Breadth and Head Length: read from Curve for each Age.

Central Age	Inches		Millimetres		Central Age	Inches		Millimetres	
	Breadth	Length	Breadth	Length		Breadth	Length	Breadth	Length
3·5	5·41	6·73	137·4	170·9	*29·5*	5·76	7·29	146·3	185·2
4·5	5·44	6·80	138·2	172·7	*30·5*	5·76	7·29	146·4	185·2
5·5	5·46	6·84	138·7	173·7	*31·5*	5·76	7·29	146·4	185·2
6·5	5·49	6·89	139·4	175·0	*32·5*	5·76	7·29	146·4	185·2
7·5	5·52	6·93	140·2	176·0	*33·5*	5·76	7·29	146·5	185·2
8·5	5·55	6·98	141·0	177·3	*34·5*	5·76	7·29	146·5	185·2
9·5	5·57	7·02	141·5	178·3	*35·5*	5·77	7·29	146·6	185·2
10·5	5·60	7·07	142·2	179·6	*36·5*	5·77	7·29	146·6	185·2
11·5	5·63	7·11	143·0	180·6	*37·5*	5·77	7·29	146·6	185·2
12·5	5·65	7·14	143·5	181·4	*38·5*	5·77	7·29	146·6	185·2
13·5	5·68	7·18	144·3	182·4	*39·5*	5·77	7·29	146·6	185·2
14·5	5·71	7·22	145·0	183·4	*40·5*	5·77	7·29	146·7	185·3
15·5	5·73	7·24	145·5	183·9	*41·5*	5·78	7·29	146·8	185·3
16·5	5·74	7·26	145·8	184·4	*42·5*	5·78	7·29	146·8	185·3
17·5	5·74	7·27	145·8	184·7	*43·5*	5·78	7·29	146·9	185·4
18·5	5·74	7·28	145·9	184·9	*44·5*	5·78	7·30	147·0	185·4
19·5	5·74	7·28	146·0	184·9	*45·5*	5·78	7·30	147·0	185·4
20·5	5·74	7·28	146·1	184·9	*46·5*	5·79	7·31	147·1	185·7
21·5	5·75	7·28	146·1	185·0	*47·5*	5·79	7·32	147·1	185·9
22·5	5·75	7·28	146·1	185·0	*48·5*	5·79	7·33	147·2	186·2
23·5	5·75	7·28	146·1	185·0	*49·5*	5·80	7·34	147·3	186·4
24·5	5·75	7·28	146·2	185·1	*50·5*	5·80	7·36	147·4	186·9
25·5	5·75	7·28	146·2	185·1	*51·5*	5·81	7·38	147·6	187·5
26·5	5·75	7·28	146·2	185·1	*52·5*	5·81	7·39	147·7	187·7
27·5	5·75	7·29	146·3	185·2	*53·5*	5·82	7·41	147·8	188·2
28·5	5·75	7·29	146·3	185·2	Above *53·5*	5·86	7·55	148·8	191·8

Tables V to X inclusive give the correlation tables of head size and shape with reaction to sound and sight. The method of determining this reaction is described by Koga and Morant*. We find the following values for the coefficients of correlation and the correlation ratios.

	r	η	η^2	$\bar{\eta}^2$
Head Breadth, Reaction Time to Sound	$-\cdot0787\pm\cdot0156$	·1193	·014223	·005995
Head Length " " "	$-\cdot0188\pm\cdot0165$	·1058	·011202	·008353
Cephalic Index " " "	$-\cdot0112\pm\cdot0165$	·0608	·003699	·010180
Head Breadth, Reaction Time to Sight	$-\cdot0353\pm\cdot0157$	·0649	·004211	·005998
Head Length " " "	$-\cdot0377\pm\cdot0165$	·1049	·011003	·008358
Cephalic Index " " "	$\cdot0161\pm\cdot0165$	·0567	·003214	·010186

There is a small negative but significant correlation of head breadth and reaction time to sound; with a smaller and insignificant value for head breadth and reaction time to sight. There is also a small correlation, negative between head length and head breadth and reaction to sight, but in all cases with the

* *Biometrika*, Vol. xv. p. 346.

TABLE IV.

Standard Deviations by Years of Head Breadths and Lengths in Inches and Millimetres.

Central Age	Inches		Millimetres	
	Breadth	Length	Breadth	Length
5·73	·151	·184	3·84	4·67
8	·189	·243	4·80	6·17
10	·178	·211	4·52	5·36
11·5	·183	·284	4·65	7·21
12·5	·230	·182	5·84	4·62
13·5	·193	·214	4·90	5·44
14·5	·205	·219	5·21	5·56
15·5	·180	·213	4·57	5·41
16·5	·191	·258	4·85	6·55
17·5	·183	·207	4·65	5·26
18·5	·171	·243	4·34	6·17
19·5	·184	·268	4·67	6·81
20·5	·171	·213	4·34	5·41
21·5	·159	·241	4·04	6·12
22·5	·177	·225	4·50	5·72
23·5	·179	·243	4·55	6·17
24·5	·211	·242	5·36	6·15
25·5	·198	·227	5·03	5·77
26·5	·190	·214	4·83	5·44
27·5	·216	·250	5·49	6·35
28·5	·165	·241	4·19	6·12
29·5	·138	·220	3·51	5·59
30·5	·177	·240	4·50	6·10
31·5	165	·205	4·19	5·21
32·5	173	·226	4·39	5·74
33·5	·176	·266	4·47	6·76
34·5	·244	·283	6·20	7·19
35·5	·192	·213	4·88	5·41
36·5	·121	·197	3·07	5·00
37·5	·150	·251	3·81	6·38
39	·159	·163	4·04	4·14
41	·149	·208	3·78	5·28
43	·191	·259	4·85	6·58
45	·224	·176	5·69	4·47
47	·182	·286	4·62	7·26
49·5	·119	·171	3·02	4·34
52·5	·176	·243	4·47	6·17
55·5	·146	·206	3·71	5·23
59·5	·130	·262	3·30	6·65
67·63	·113	·210	2·87	5·33

exception of head breadth and reaction to sound the value of r is not significant having regard to its probable error, and is therefore negligible.

Turning to the correlation ratio we see that η^2 is only significant compared with $\overline{\eta}^2$ (the mean value of η^2 in samples from a population with zero correlation) in the case of head breadth and reaction time to sound. As far as cephalic

index is concerned the correlation coefficient is zero and the correlation ratio is insignificant for both reaction times, or mental agility is not associated with either brachycephaly or dolichocephaly.

In conclusion, while there is a small amount of correlation between head breadth and reaction time to sound, its intensity is so slight as to be of no prognostic value. In all other cases the intensity of correlation is of no significance, and the reaction times in this agree with the measurements of other mental characters.

I wish to express my gratitude to Prof. Karl Pearson not only for the use of this material, but also for his valuable suggestions; and to Miss Ida McLearn for making Diagrams I and II.

TABLE V.

Galton's Anthropometric Data, Second Laboratory Series, Females.
Reaction Time to Sound and Head Breadth, both Corrected for Age.

Central Values. Head Breadth in Inches.

Central Values of Reaction Time to Sound in $\frac{1}{100}$".	5·105	5·205	5·305	5·405	5·505	5·605	5·705	5·805	5·905	6·005	6·105	6·205	6·305	6·405	6·505	6·605	6·705	6·805	6·905	Totals
4·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
5·45	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1
6·45	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
7·45	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	2
8·45	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	2
9·45	—	—	1	—	3	1	4	6	—	2	1	1	—	—	—	—	—	—	—	19
10·45	—	—	—	1	6	10	8	10	7	5	1	1	—	—	—	—	—	—	—	49
11·45	—	—	1	3	7	14	22	13	11	14	4	—	—	—	—	—	—	—	—	89
12·45	—	—	1	4	6	11	35	25	23	9	4	—	—	—	—	—	—	—	—	118
13·45	—	—	1	3	10	28	33	34	28	10	4	2	—	—	—	—	—	—	—	153
14·45	—	—	1	8	27	42	76	70	54	24	9	3	4	—	1	—	—	—	—	319
15·45	—	1	3	14	35	41	57	54	62	38	8	1	2	—	—	—	—	—	—	316
16·45	—	1	1	7	22	44	58	47	37	18	3	7	1	—	—	—	—	—	—	246
17·45	—	—	1	5	16	23	30	27	26	15	7	—	—	—	—	—	—	—	1	151
18·45	—	—	1	4	10	23	27	14	18	9	6	2	—	—	—	—	—	—	—	114
19·45	—	—	2	3	11	9	19	24	16	4	3	—	—	—	—	1	—	—	—	92
20·45	—	1	1	3	9	10	17	12	16	6	—	1	—	—	—	—	—	—	—	76
21·45	—	—	—	—	2	4	2	3	5	1	—	—	—	—	—	—	—	—	—	17
22·45	—	1	1	—	2	1	8	5	1	—	—	—	—	—	—	—	—	—	—	19
23·45	—	1	—	2	1	2	1	5	1	1	—	—	—	—	—	—	1	—	—	15
24·45	1	—	—	1	1	2	4	2	2	—	—	—	—	—	—	—	—	—	—	13
25·45	—	—	—	1	—	2	2	—	1	—	—	—	—	—	—	—	—	—	—	6
26·45	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	2
27·45	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	2
28·45	—	—	—	—	1	—	2	1	1	—	—	—	—	—	—	—	—	—	—	5
29·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
30·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
31·45	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
32·45	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
33·45	—	—	1	—	—	1	2	—	—	—	—	—	—	—	—	—	—	—	—	4
34·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
35·45	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	2
Totals	1	5	16	60	172	271	409	354	312	156	50	18	7	0	1	1	1	0	1	1835

TABLE VI.

Galton's Anthropometric Data, Second Laboratory Series, Females.
Reaction Time to Sound and Head Length, both Corrected for Age.

Central Values. Head Length in Inches.

Central Values of Reaction Time to Sound in $\frac{1}{100}$".

	6·505	6·605	6·705	6·805	6·905	7·005	7·105	7·205	7·305	7·405	7·505	7·605	7·705	7·805	7·905	8·005	8·105	Totals
4·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
5·45	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
6·45	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
7·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
8·45	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	2
9·45	—	—	—	—	—	3	4	4	4	—	—	1	—	1	—	—	—	17
10·45	—	1	—	—	2	5	2	8	5	8	3	1	1	1	—	—	—	37
11·45	—	—	—	—	5	7	14	15	17	9	8	4	2	2	—	—	—	83
12·45	—	—	2	1	1	6	14	20	25	10	13	15	3	2	—	1	—	113
13·45	—	—	1	3	2	3	21	28	33	27	15	7	5	1	—	1	—	147
14·45	2	—	3	10	8	17	41	50	57	44	30	14	11	8	1	1	—	297
15·45	1	1	3	9	20	26	26	47	65	41	23	18	10	2	3	—	1	296
16·45	—	—	—	3	16	24	25	29	50	41	24	14	8	2	4	1	1	242
17·45	—	1	1	1	6	15	22	27	20	23	11	10	6	3	—	—	—	146
18·45	—	—	—	1	6	9	11	21	20	13	8	6	4	1	—	1	—	101
19·45	—	—	—	4	4	9	6	19	6	12	7	3	5	2	—	1	—	78
20·45	—	—	4	2	3	4	9	8	9	14	5	2	2	—	1	—	—	63
21·45	—	—	1	—	—	—	1	4	3	3	1	1	—	—	—	—	—	14
22·45	—	—	—	—	1	1	2	3	3	3	—	2	—	—	—	—	—	15
23·45	—	—	—	—	—	1	1	2	2	—	—	1	—	—	—	—	—	7
24·45	—	—	—	—	—	—	1	—	4	1	—	—	—	—	1	—	—	7
25·45	—	—	—	1	—	—	—	2	—	—	—	—	—	—	—	—	—	3
26·45	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
27·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
28·45	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
29·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
30·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
31·45	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1
32·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
33·45	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	2
34·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
35·45	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Totals	3	3	16	35	75	131	200	290	325	249	149	99	57	26	10	6	2	1676

TABLE VII.

Galton's Anthropometric Data, Second Laboratory Series, Females.
Reaction Time to Sight and Head Breadth, both Corrected for Age.

Central Values. Head Breadth in Inches.

Central Values of Reaction Time to Sight in $\frac{1}{100}$".

	5·105	5·205	5·305	5·405	5·505	5·605	5·705	5·805	5·905	6·005	6·105	6·205	6·305	6·405	6·505	6·605	6·705	6·805	6·905	Totals
4·45	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
5·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
6·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
7·45	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
8·45	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
9·45	—	—	—	—	—	1	3	3	—	1	—	—	—	—	—	—	—	—	—	8
10·45	—	—	—	1	4	5	3	3	4	3	1	1	1	—	—	—	—	—	—	26
11·45	—	—	—	—	2	1	4	3	3	2	1	—	—	—	—	—	—	—	—	16
12·45	—	—	1	—	2	1	5	9	1	2	1	—	—	—	—	—	—	—	—	22
13·45	—	—	—	1	—	5	2	3	2	4	1	—	—	—	—	—	—	—	—	18
14·45	—	—	2	2	7	8	14	14	7	7	1	—	—	—	—	—	—	—	—	62
15·45	—	1	2	3	4	17	27	27	12	8	1	—	—	—	—	—	—	—	—	102
16·45	—	1	—	—	14	24	42	24	33	10	7	—	—	—	1	—	—	—	—	156
17·45	—	—	—	9	20	21	36	42	40	20	11	5	2	—	—	—	—	—	—	206
18·45	—	1	3	7	20	32	49	46	36	18	6	5	1	—	—	—	—	—	—	224
19·45	1	—	1	6	23	39	57	51	43	21	5	2	2	—	—	—	—	—	—	251
20·45	—	—	4	13	23	40	63	40	45	30	6	—	1	—	—	—	—	—	—	265
21·45	—	—	—	3	11	21	30	22	23	8	2	2	—	—	—	—	—	—	—	122
22·45	—	—	1	2	9	11	16	14	23	4	2	—	—	—	—	1	—	—	—	83
23·45	—	—	—	4	10	10	16	15	10	1	—	2	—	—	—	—	—	—	—	68
24·45	—	1	1	4	10	12	15	12	17	8	3	—	—	—	—	—	—	—	—	83
25·45	—	—	—	1	6	10	12	10	4	6	2	1	—	—	—	—	1	—	—	53
26·45	—	—	—	—	2	5	2	2	3	1	—	—	—	—	—	—	—	—	1	16
27·45	—	—	—	1	—	2	3	3	4	—	—	—	—	—	—	—	—	—	—	13
28·45	—	—	—	—	—	1	1	4	—	1	—	—	—	—	—	—	—	—	—	7
29·45	—	1	—	1	—	2	2	2	—	1	—	—	—	—	—	—	—	—	—	9
30·45	—	—	—	—	1	2	1	2	1	—	—	—	—	—	—	—	—	—	—	7
31·45	—	—	1	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	3
32·45	—	—	—	—	1	—	2	2	—	—	—	—	—	—	—	—	—	—	—	5
33·45	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
34·45	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
35·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
36·45	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	2
37·45	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
Totals	1	5	16	60	172	271	408	354	312	156	50	18	7	0	1	1	1	0	1	1834

TABLE VIII.

Galton's Anthropometric Data, Second Laboratory Series, Females.
Reaction Time to Sight and Head Length, both Corrected for Age.

Central Values. Head Length in Inches.

Central Values of Reaction Time to Sight in $\frac{1}{100}$″.	6·505	6·605	6·705	6·805	6·905	7·005	7·105	7·205	7·305	7·405	7·505	7·605	7·705	7·805	7·905	8·005	8·105	Totals
4·45	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
5·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
6·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
7·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
8·45	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
9·45	—	—	—	1	—	1	2	1	—	—	2	—	—	—	—	—	—	7
10·45	—	—	—	—	2	1	2	4	2	4	1	—	2	—	—	—	—	18
11·45	—	—	—	—	1	1	2	1	6	2	—	—	1	—	1	—	—	15
12·45	—	—	1	—	—	1	3	7	3	3	—	—	1	—	—	—	—	19
13·45	—	—	—	—	—	3	2	6	2	3	—	1	—	—	—	—	—	17
14·45	—	1	1	3	—	4	7	10	9	5	6	4	1	—	—	—	—	51
15·45	—	—	—	4	2	2	16	13	21	12	7	5	1	2	—	1	—	86
16·45	—	—	1	2	8	6	16	33	34	26	13	8	4	1	—	—	—	152
17·45	1	—	1	1	6	12	17	30	40	30	27	15	9	6	1	1	—	197
18·45	1	1	—	3	5	22	26	26	45	34	18	14	7	4	4	1	1	212
19·45	1	1	2	4	14	22	34	35	46	27	29	16	9	2	1	1	—	244
20·45	—	—	2	4	11	17	28	44	44	42	21	13	11	4	2	1	—	244
21·45	—	—	1	3	4	12	8	24	24	25	9	4	3	—	—	—	1	118
22·45	—	—	3	2	8	6	11	13	12	15	3	1	2	2	—	1	—	79
23·45	—	—	1	5	4	3	8	10	10	4	7	7	2	1	—	—	—	62
24·45	—	—	2	2	4	5	7	12	13	9	1	6	3	2	1	—	—	67
25·45	—	—	—	1	2	8	5	8	8	5	3	3	1	1	—	—	—	45
26·45	—	—	—	—	1	3	1	5	2	2	1	—	—	—	—	—	—	15
27·45	—	—	—	—	—	—	2	2	2	1	1	—	—	—	—	—	—	8
28·45	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	2
29·45	—	—	—	—	1	1	1	1	—	—	—	1	—	—	—	—	—	5
30·45	—	—	—	—	—	—	1	1	—	—	—	1	—	—	—	—	—	3
31·45	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	2
32·45	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	3
33·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
34·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
35·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
36·45	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
37·45	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
Totals	3	3	16	35	75	131	199	290	325	249	149	99	57	26	10	6	2	1675

TABLE IX.

Galton's Anthropometric Data, Second Laboratory Series, Females. Cephalic Index and Reaction Time to Sound, the latter Corrected for Age.

Central Values. Cephalic Index.

Central Values of Reaction Time to Sound in $\frac{1}{100}$".

	69·05	70·05	71·05	72·05	73·05	74·05	75·05	76·05	77·05	78·05	79·05	80·05	81·05	82·05	83·05	84·05	85·05	86·05	87·05	88·05	89·05	90·05	91·05	92·05	93·05	94·05	95·05	96·05	97·05	98·05	99·05	Totals
5·45	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
6·45	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
7·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
8·45	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
9·45	—	—	—	—	—	—	2	—	—	2	5	2	2	—	2	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17
10·45	—	—	—	—	—	2	4	3	2	7	3	3	6	2	3	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	37
11·45	—	—	1	—	—	1	4	7	9	13	13	10	11	8	3	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	83
12·45	—	1	—	—	2	3	7	17	13	14	16	9	14	8	3	4	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	113
13·45	—	—	1	1	3	8	4	10	15	26	27	17	9	16	2	4	1	1	1	—	—	—	—	—	1	—	—	—	—	—	—	147
14·45	—	—	1	1	5	15	10	24	32	37	46	28	26	24	19	15	5	4	2	1	1	—	—	—	—	—	—	—	—	—	—	296
15·45	—	—	1	2	7	7	13	26	32	33	44	34	33	17	20	9	8	4	4	1	—	—	—	—	—	—	—	—	—	—	—	295
16·45	—	—	—	2	6	7	14	35	29	23	23	29	30	14	10	9	4	3	2	—	—	—	—	—	—	—	—	—	—	—	—	240
17·45	—	—	1	—	1	2	12	16	14	14	24	16	15	14	5	7	4	—	—	—	—	—	—	—	—	—	—	—	—	—	1	146
18·45	1	—	1	—	2	4	2	5	11	22	14	11	10	6	4	4	2	1	1	—	—	—	—	1	—	—	—	—	—	—	—	101
19·45	—	—	2	—	—	5	5	5	10	5	15	6	11	4	5	1	2	1	—	—	—	—	—	1	—	—	—	—	—	—	—	78
20·45	—	1	—	—	—	1	2	4	9	10	11	3	9	4	6	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	63
21·45	—	—	—	1	—	—	1	1	—	2	2	4	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14
22·45	—	—	—	—	—	—	—	2	1	3	6	—	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15
23·45	—	—	—	—	1	—	—	1	1	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6
24·45	—	—	—	—	—	—	—	1	1	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6
25·45	—	—	—	—	—	—	—	—	—	1	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
26·45	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
27·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
28·45	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
29·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
30·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
31·45	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
32·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
33·45	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
34·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
35·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Totals	1	2	8	7	27	56	81	157	179	217	255	173	180	119	85	58	34	15	10	2	1	0	0	1	1	0	0	0	0	0	1	1670

TABLE X.

Galton's Anthropometric Data, Second Laboratory Series, Females. Cephalic Index and Reaction Time to Sight, the latter Corrected for Age.

Central Values. Cephalic Index.

Central Values of Reaction Time to Sight in $\frac{1}{100}$".	69·05	70·05	71·05	72·05	73·05	74·05	75·05	76·05	77·05	78·05	79·05	80·05	81·05	82·05	83·05	84·05	85·05	86·05	87·05	88·05	89·05	90·05	91·05	92·05	93·05	94·05	95·05	96·05	97·05	98·05	99·05	Totals
4·45	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
5·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
6·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
7·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
8·45	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
9·45	—	—	—	—	—	—	1	—	—	1	—	2	1	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
10·45	—	—	—	—	—	1	—	2	1	4	4	4	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18
11·45	—	—	—	—	—	—	3	—	1	2	1	3	2	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15
12·45	—	—	1	—	—	1	1	—	—	4	2	2	4	2	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	19
13·45	—	—	—	—	—	1	—	1	—	1	4	3	3	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17
14·45	—	—	—	—	1	—	3	10	2	7	7	3	4	6	6	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	51
15·45	—	1	—	—	—	2	3	9	16	9	19	2	7	8	5	4	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	86
16·45	—	—	—	—	1	4	6	13	17	22	25	15	21	15	5	6	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	152
17·45	—	—	—	2	8	8	11	16	25	28	29	15	20	10	9	2	5	4	2	2	—	—	—	—	—	—	—	—	—	—	—	196
18·45	1	—	—	1	5	9	9	17	25	31	32	22	22	13	12	7	2	2	1	—	—	—	—	—	—	—	—	—	—	—	—	211
19·45	—	—	2	1	4	6	12	30	26	23	34	32	22	14	12	12	8	2	3	—	1	—	—	—	—	—	—	—	—	—	—	244
20·45	—	—	4	—	4	11	8	24	28	38	33	28	22	17	8	12	1	2	1	—	—	—	—	—	1	—	—	—	—	—	—	242
21·45	—	—	1	—	3	3	7	12	9	12	18	18	16	10	5	1	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	118
22·45	—	1	—	1	—	2	3	7	4	10	12	8	10	3	7	4	4	2	—	—	—	—	—	1	—	—	—	—	—	—	—	79
23·45	—	—	—	2	—	4	4	4	6	7	9	5	7	6	4	1	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	62
24·45	—	—	—	—	1	2	6	4	12	8	5	5	7	5	5	3	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	66
25·45	—	—	—	—	—	1	3	3	4	4	12	2	9	2	2	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	44
26·45	—	—	—	—	—	—	—	1	1	2	4	2	1	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	15
27·45	—	—	—	—	—	—	—	2	—	2	2	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
28·45	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
29·45	—	—	—	—	—	—	—	1	1	—	—	—	—	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
30·45	—	—	—	—	—	—	—	—	1	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
31·45	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
32·45	—	—	—	—	—	—	—	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
33·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
34·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
35·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
36·45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
37·45	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Totals	1	2	8	7	27	56	81	157	179	217	255	173	180	118	85	58	34	15	10	2	1	0	0	1	1	0	0	0	0	0	1	1669

ON THE DEGREE OF RELATIONSHIP BETWEEN HEAD MEASUREMENTS AND REACTION TIME TO SIGHT AND SOUND.

By G. E. HARMON, M.D., School of Medicine of Western Reserve University.

PREVIOUS investigations from the Biometric Laboratory* have indicated that only the smallest relationship between head measurements and intelligence exists. For women it has also been shown by Musselman† that the relationship between head measurements and reaction times to sight and sound is very small. Indeed the degree of association in the cases studied was too small to be of any real value for prognostic purposes.

The present study deals with the data for males in Francis Galton's Second Anthropometric Laboratory Series which were put at my disposal by the Director of the Galton Laboratory, University of London. About 5600 individuals are included in these data. The measurements were taken in inches, and though the computations involved in this paper were made in this unit, I have for convenience expressed many of the constants in the now more usual millimetres. In the case of head length only those individuals have been included on whom the measurement was taken from the glabella to the occipital point. At the beginning of the series head length was measured from the nasion to the occipital point. All individuals so measured have been excluded.

Both head measurements have been corrected for age by the method described by Holzinger (*Biometrika*, Vol. XVI. p. 140), taking age 40·5 as the standard age to which all other ages were reduced. In Diagrams I and II will be found curves of the means and the standard deviations for head breadths and lengths by years. The dotted portion of the curve of means indicates the years for which the numbers of observations were quite small. In the case of breadth the formula used in making the corrections was $y_s = \bar{y}_s + (y_t - \bar{y}_t)\frac{\sigma_s}{\sigma_t}$, in which s refers to the standard age 40·5 and t to any other age, while y_s is the value of any observation y_t reduced to the standard age. The values for σ_s and values for σ_t are given in Table VII and for $\bar{y}_s$ and $\bar{y}_t$ in Table VI. The standard deviations of head lengths were found to be well represented by a horizontal straight line corresponding to ·244 inches, the value of the weighted average of the standard deviations. For this case $\frac{\sigma_s}{\sigma_t}$ becomes unity, and the formula for correcting for age becomes $y_s = \bar{y}_s + (y_t - \bar{y}_t)$. The values for $\bar{y}_s$ and $\bar{y}_t$ may be found in Table VI.

* *Biometrika*, Vol. v. p. 105.

† See present issue of *Biometrika*, pp. 195—206.

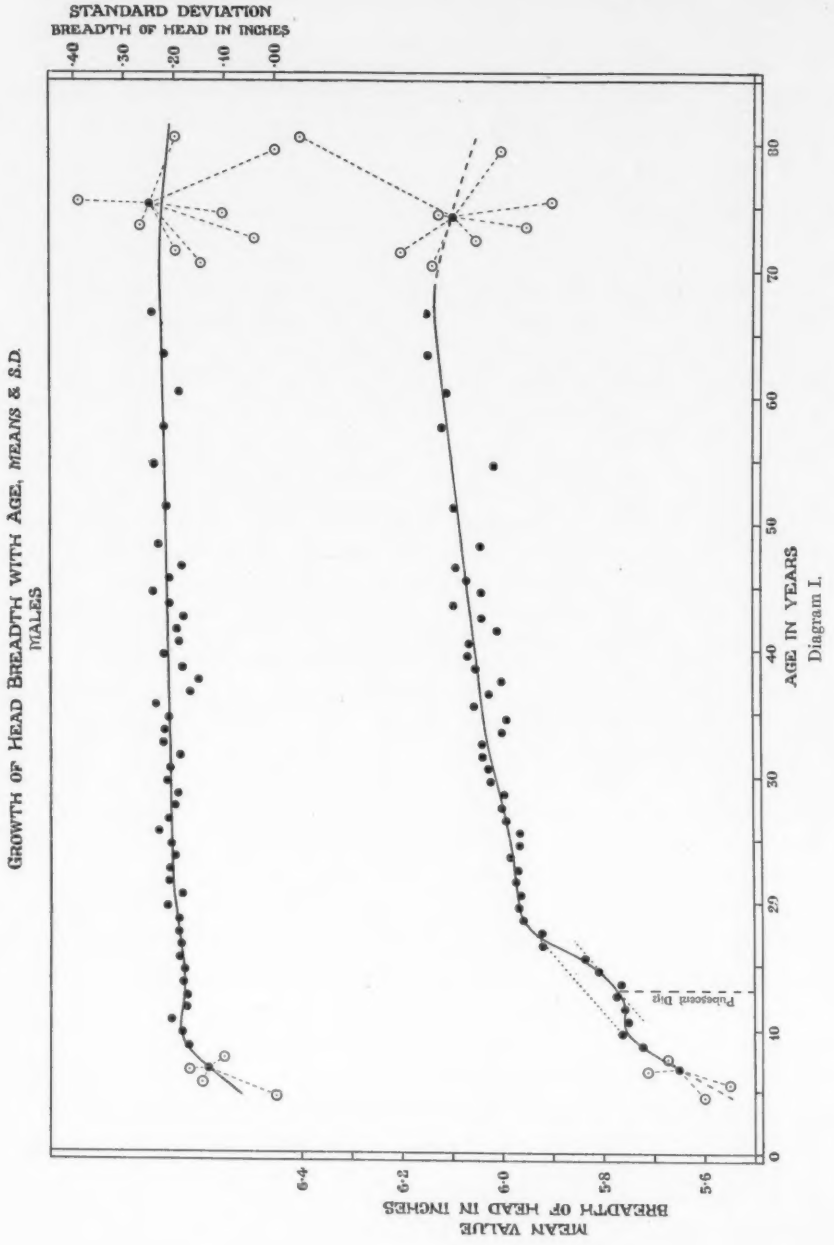

STANDARD DEVIATION
BREADTH OF HEAD IN INCHES
·40
·30
·20
·10
·00
GROWTH OF HEAD BREADTH WITH AGE, MEANS & S.D.
MALES
Pubescent Dip
MEAN VALUE
BREADTH OF HEAD IN INCHES
6·4
6·2
6·0
5·8
5·6
0
10
20
30
40
50
60
70
80
AGE IN YEARS

Diagram I.

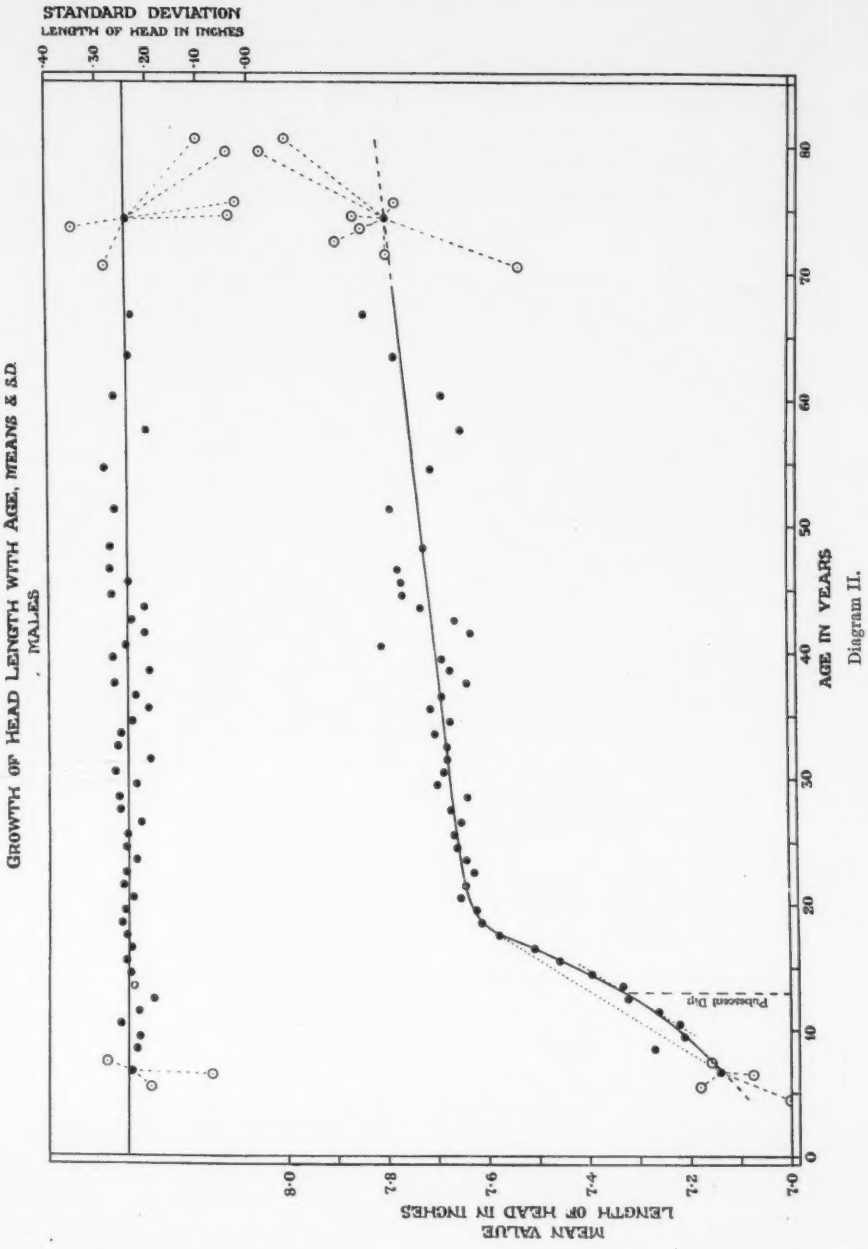

STANDARD DEVIATION
LENGTH OF HEAD IN INCHES
·40
·30
·20
·10
·00
GROWTH OF HEAD LENGTH WITH AGE, MEANS & S.D.
MALES
MEAN VALUE
LENGTH OF HEAD IN INCHES
8·0
7·8
7·6
7·4
7·2
7·0
AGE IN YEARS
0
10
20
30
40
50
60
70
80
Pubescent Dip

Diagram II.

Before correction the mean head breadth of 5615 individuals was 5·951 inches or 151·164 mm. and the mean head length of 4721 individuals was 7·594 inches or 192·898 mm. In Table I will be found a comparison of head measurements before and after correction.

TABLE I.

Head Measurements before and after Correction for Age.*

Character	Before Correction for Age			After Correction for Age		
	Mean	Standard Deviation	Coefficient of Variation	Mean	Standard Deviation	Coefficient of Variation
Breadth	151·164 mm.	5·659 mm.	3·744	153·808 mm.	5·460 mm.	3·550
Length	192·898 mm.	7·062 mm.	3·661	195·563 mm.	6·261 mm.	3·202
Cephalic Index	78·346	2·975	3·797	[78·649]†	—	—

It will be noticed that the means after correction for age are higher, owing to the frequency being greater before than after age 40·5. The variability is decreased by the reduction of the measurements to a standard age as we should naturally expect.

In Table II will be found the means, standard deviations, and coefficients of variation for reaction times in men based upon the results obtained in the case of 5563 and 5564 individuals.

TABLE II.

Reaction Times in Males in $\frac{1}{100}$ths of a Second.*

	Mean	Standard Deviation	Coefficient of Variation
Reaction Time to Sight	18·774	3·570	19·016
„ „ Sound	15·583	2·984	19·149

It will be observed that the reaction time to sight is greater than that to sound and there is considerable variability exhibited by these characters. The method of determining these reaction times has been described by Koga and Morant‡. Comparing with Musselman's results, we see that there is very little difference between male and female reaction times, the male being slightly quicker than the female. In relative variability, both sexes have identical coefficients for

* Constants in each case were calculated from the distribution with the greatest frequency for that variate.

† Ratio of reduced means.

‡ *Biometrika*, Vol. xv. p. 347.

TABLE III. *Ga*

Head Breadth in Inches. Central Values.

	4—7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
5·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5·1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5·2	—	—	—	—	—	—	2	—	—	—	—	0·5	0·5	—	—	—
5·3	—	—	2	3	1	2	—	—	0·5	0·5	—	0·5	0·5	1	2	0·5
5·4	2	0·5	0·5	4·5	2·5	1	6	3·5	3·5	1·5	0·5	2	3·5	0·5	3	0·5
5·5	4·5	4·5	3	2·5	8·5	6·5	19·5	16	12·5	5·5	8·5	4	7·5	3	6	5·5
5·6	4	4·5	4·5	9·5	10	17	22·5	24·5	16	13	20·5	11	11	15·5	5	6·5
5·7	6·5	4	8	10	22	31·5	34	34·5	50	23·5	45	41	35·5	30	28·5	28·5
5·8	4·5	4·5	8	12	23	20·5	36·5	49·5	41·5	45·5	43·5	60·5	62	56	40	35
5·9	1·5	3	8·5	7	10	18	34	35	40·5	64	68	83	73	82	56·5	36·5
6·0	—	2	5	6·5	7	11·5	23·5	35	33·5	48·5	71	95	89·5	100·5	61	63
6·1	—	1	1·5	4	4	4	6·5	11	17·5	36	44·5	60	70	49·5	46	37
6·2	—	—	—	—	1·5	4	0·5	3	7·5	13	26	33·5	42	33	30	22·5
6·3	—	—	—	—	0·5	—	1	2	3	8·5	10	22	16·5	23·5	20·5	10·5
6·4	—	—	—	—	—	—	—	0·5	1	4·5	3·5	2	8·5	6·5	9	6
6·5	—	—	—	—	—	—	—	0·5	1	1	2	4	2	3	3·5	4
6·6	—	—	—	1	—	—	—	—	—	—	—	0·5	1·5	—	—	1
6·7	—	—	—	—	—	—	—	—	—	—	—	1·5	0·5	—	—	0·5
6·8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0·5
6·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7·1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7·2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7·3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7·4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7·6	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
Totals	23	24	41	60	90	116	186	215	228	265	343	421	425	404	311	258

Mean

TABLE I

Head Length in Inches. Central Values.

	4—7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
6·6	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—
6·7	—	—	1	0·5	—	—	—	1	1	0·5	—	0·5	—	—	—
6·8	1·5	—	1	1	2	0·5	2	—	—	1	—	1·5	1	—	—
6·9	2·5	1·5	2	4	3	1·5	6·5	4·5	1·5	3	2	2	1	—	—
7·0	5	4	4	10	7·5	5·5	9·5	10·5	8·5	1	5·5	3·5	2	1	—
7·1	4	2·5	4	7	9	10·5	16	16·5	15·5	10·5	8·5	7	5·5	4	2·5
7·2	2	2·5	4	8·5	9	22·5	25	23·5	16·5	14·5	10	12·5	13·5	10	16·5
7·3	3	3·5	8	5	14	18	27	23	19·5	31·5	22	21·5	22	17·5	13·5
7·4	—	4	4	3	15·5	16	26	25	30·5	29	38	42·5	30	36·5	18
7·5	—	1	2	1	9	14	23	42	36	35	46	52	51·5	41·5	39
7·6	—	3	1	5	1	7	16	24	29·5	40·5	53	47·5	59·5	44	42
7·7	—	1	1	2	0·5	5·5	11	10	18·5	32	42	55·5	57·5	57	44
7·8	1	—	—	2	2·5	1	3	6	10·5	19	31	44·5	35	55·5	24
7·9	—	—	—	—	—	—	—	3·5	11·5	6	15·5	29·5	23·5	28·5	16·5
8·0	—	—	—	—	—	—	1	3·5	1	5·5	14·5	20	23·5	20·5	15
8·1	—	—	—	—	—	—	—	—	—	3	3	9·5	6	9	10·5
8·2	—	—	—	—	—	—	—	—	—	—	4	3	2·5	3	6·5
8·3	—	—	—	—	—	—	—	—	1	—	0·5	1·5	1·5	1	1
8·4	—	—	—	—	—	—	—	—	—	—	0·5	—	1·5	1	0·5
8·5	—	—	—	—	—	—	—	—	—	—	—	—	1	—	0·5
8·6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals	21	23	32	49	74	102	167	193	201	232	296	354	338	330	250

TABLE III. *Galton's Anthropometric Data, Second Laboratory Series, Males.*

Age in Years (with the same meaning as in Table V

18	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*	*31*	*32*	*33*	*34*
—	—	—	—	—	—	—	—	0·5	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	0·5	—	—	—	—	—	—	—	—
0·5	0·5	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
0·5	0·5	1	2	0·5	—	—	—	—	—	—	—	—	0·5	—	—	—
2	3·5	0·5	3	0·5	—	1·5	—	—	—	1	0·5	—	0·5	0·5	—	1
4	7·5	3	6	5·5	3	4	3	1·5	1	—	1·5	1·5	—	2·5	1	1
11	11	15·5	5	6·5	6·5	2·5	6·5	4·5	6	2·5	—	2	1	—	2·5	2
41	35·5	30	28·5	28·5	15	14·5	15	11·5	9	8·5	12	3·5	1·5	4·5	4	1
60·5	62	56	40	35	26	24	18	20·5	13	14	6·5	10·5	8	4·5	5·5	11
83	73	82	56·5	36·5	46	30·5	26	30	21	20·5	14·5	18	12·5	9	13	7
95	89·5	100·5	61	63	47·5	36·5	25	36·5	33·5	20	13·5	14	19	13	10·5	16
60	70	49·5	46	37	24·5	21	22·5	26·5	23·5	22·5	19	15·5	18	15	10·5	12
33·5	42	33	30	22·5	23·5	15	9·5	20	14·5	12·5	15	11	10·5	6	6·5	9
22	16·5	23·5	20·5	10·5	14·5	7·5	7·5	7·5	8	6	5·5	6	3·5	7·5	5·5	5
2	8·5	6·5	9	6	5	4	5	4·5	2	2·5	4	5·5	4	3	2	0
4	2	3	3·5	4	1·5	1	3	—	2·5	2	3	2·5	2	2·5	—	—
0·5	1·5	—	—	1	—	2	—	1	—	—	—	—	—	—	—	1
1·5	0·5	—	—	0·5	—	—	—	2	1	—	—	—	—	—	—	—
—	—	—	—	0·5	0·5	—	1	—	—	—	—	—	—	—	1	—
—	—	—	—	—	0·5	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
421	425	404	311	258	214	164	143	167	135	112	95	90	81	68	62	7

Mean Head Breadth 5·951 inches or 151·164 mm. Standard Deviation ·223 in

TABLE IV. *Galton's Anthropometric Data, Second Laboratory Series, M*

Age in Years (with the same meaning as in Tab

17	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*	*31*	*32*	*33*
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	0·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1·5	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—
2	2	1	—	—	1	—	—	—	—	—	1	—	—	—	—	—
5·5	3·5	2	1	—	2·5	—	1	—	—	1	1	—	1·5	—	—	1
8·5	7	5·5	4	2·5	3·5	1·5	4·5	1·5	—	2	0·5	1	1·5	—	1	—
10	12·5	13·5	10	16·5	4·5	5·5	1	5	3·5	2	3·5	1	2	2	4·5	0
22	21·5	22	17·5	13·5	6·5	12·5	4·5	8·5	5·5	7·5	5·5	2·5	2	3	1·5	3
38	42·5	30	36·5	18	25·5	14·5	9·5	10	16·5	11	10·5	5·5	8·5	3·5	3	4
46	52	51·5	41·5	39	38·5	23·5	25	14	22	14·5	7	7	8	8·5	4	6
53	47·5	59·5	44	42	31	31·5	14·5	14	27·5	13·5	15·5	16	7	13·5	9	7
42	55·5	57·5	57	44	34·5	22	13	21	16·5	15·5	16·5	12·5	12	8·5	12	9
31	44·5	35	55·5	24	25	23	23·5	13	21	17	10	12	19	15	8	8
15·5	29·5	23·5	28·5	16·5	14	14·5	13·5	19	14	13	6·5	7	7·5	8	3	6
14·5	20	23·5	20·5	15	15	12	7	9·5	7·5	5	6·5	6	4	4·5	2	3
3	9·5	6	9	10·5	4	6·5	4	2·5	3	9	2·5	2·5	2·5	1·5	4·5	1
4	3	2·5	3	6·5	2·5	—	2	1	1	1	1·5	3	2·5	—	2·5	3
0·5	1·5	1·5	1	1	2	—	1	1	—	0·5	1	—	—	—	—	1
0·5	—	1·5	1	0·5	—	—	—	—	1	0·5	—	—	—	—	—	
—	—	1	—	0·5	—	—	—	—	—	—	—	—	0·5	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	0·5	—	—	
296	354	338	330	250	211	167	124	120	139	113	89	76	79	68	55	

Mean Head Length 7·594 inches or 192·898 mm. Standard Deviation

Series, Males. Head Breadth and Age.

g as in Table V.)

32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47—49	50—52	53—55	56—58	59—61	62—64	65—69	70—80	Totals
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0·5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1·5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4·0
0·5	—	1·5	0·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0·5	14·5
2·5	1	1·5	0·5	—	1	—	—	—	1	—	—	1	1	—	—	—	—	—	—	—	—	0·5	43·0
—	2·5	2	1·5	—	—	—	1·5	—	1	0·5	—	2	—	—	1	—	0·5	—	—	—	—	—	143·0
4·5	4	1·5	2·5	2	1	3	1·5	1	1	2	2	1	0·5	1·5	5·5	2	2·5	2	1	—	3	1	569·0
4·5	5·5	11·5	6	9·5	3·5	2·5	1	6	5·5	5·5	1·5	2	2·5	1·5	5·5	6·5	3·5	2	2	4	—	—	775·0
9	13	7·5	14·5	8	11·5	5	4	4·5	8·5	3	2·5	4·5	4·5	2·5	7·5	6	4·5	5	3·5	3	2·5	—	974·0
13	10·5	16·5	10·5	6·5	13·5	9	6	8	8	10·5	3	8	4·5	6·5	16·5	15	6·5	4	5·5	4	3	6	1092·5
15	10·5	12	8	11	8·5	6·5	7	8	7	7	6·5	4	5·5	5·5	10	16	13	5·5	6·5	4·5	6	3·5	772·5
6	6·5	9	7	9·5	6	5·5	3·5	5·5	7	5·5	5·5	7·5	7·5	5	12·5	5·5	5	7·5	4·5	6·5	4·5	4·5	495·0
7·5	5·5	5·5	6·5	5·5	1	5	2	3	2	4	0·5	0·5	3	2·5	7·5	3	4	4·5	4	5	0·5	1·5	268·0
3	2	0·5	3·5	—	1	0·5	1·5	2·5	1	2	1·5	1·5	1	2	3	2·5	1·5	2	3	1	3·5	1·5	119·5
2·5	—	—	4	—	—	1	1	1·5	1	—	1·5	1	1	1	4	6	0·5	1·5	1	2·5	3	—	72·5
—	—	1	0·5	—	—	—	1	—	—	—	0·5	—	—	—	—	0·5	—	—	—	1·5	1	1	14·0
—	—	—	0·5	—	—	—	—	—	—	—	—	1	—	—	—	1	—	1	—	—	—	—	9 0
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3·0
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0·5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1·0
68	62	70	66	52	47	38	30	40	43	40	25	34	31	28	77	64	44	35	31	32	27	20	5615·0

Deviation ·223 inches or 5·659 mm.

atory Series, Males. Head Length and Age.

ing as in Table V.)

31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47—49	50—52	53—55	56—58	59—61	62—64	65—69	70—80	Totals
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2·0
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4·5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12·5
—	—	1	0·5	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	37·0
—	1	—	1·5	—	—	1	—	—	—	—	2	—	1	—	—	1	1·5	0·5	1	—	1	—	—	88·5
2	4·5	0·5	1	—	—	1	—	1	2	1·5	—	—	—	—	1	2·5	0·5	1	—	0·5	—	—	1	150·5
3	1·5	3	2	3	—	2	1·5	2	—	0·5	—	—	—	0·5	1	2·5	1	1·5	—	1·5	1	1	—	237·5
3·5	3	4·5	4·5	4	4	6	5·5	2	1·5	9	3·5	2	1·5	1·5	2	6·5	3·5	8	1	3	1	—	—	332·5
8·5	4	6	6·5	5	5·5	4	3	3	3·5	3	3	3	2·5	3	2	6	2	1	6	3·5	3	2	1·5	510·5
13·5	9	7·5	8	10	10·5	7	3·5	3	—	4·5	11·5	1·5	7	4	4·5	8·5	10	3	8·5	3	5·5	1	1·5	689·5
8·5	12	9	7·5	12	5·5	6	6	3·5	3	8·5	5	6·5	7	3·5	1	8	10	4·5	4·5	4	3·5	3	0·5	643·5
15	8	8·5	11	10	4	5	6	3	8	4·5	2	1·5	1	2	4	9·5	8·5	4·5	3	3·5	2·5	5	4·5	533·0
8	3	6·5	6·5	6	5	2	4·5	1·5	6·5	6	4	3·5	5·5	3	1·5	4·5	5·5	8	—	5	3·5	3	6	352·0
4·5	2	3·5	5·5	5·5	3	—	3	2	4	0·5	3	1	0·5	2·5	4·5	9·5	8·5	2	2·5	2	4	4	0·5	255·0
1·5	4·5	1	1·5	3·5	3·5	0·5	—	1	5·5	1	1·5	1	3	2	4	4	6	3	1·5	3	3·5	1	1·5	136·0
—	2·5	3	—	—	—	2	—	2	1	—	0·5	1	1	2	1	4	3	2·5	—	—	1·5	2·5	1	64·0
—	—	1	—	—	—	1·5	—	—	—	—	—	—	1	—	0·5	0·5	1	—	—	—	—	0·5	—	18·0
—	—	—	—	—	—	—	—	—	—	—	—	—	0·5	—	—	—	—	—	—	—	—	—	—	5·5
—	—	—	—	—	—	—	—	—	—	—	—	—	0·5	—	—	—	1	—	—	—	—	—	—	3·5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0·5
68	55	55	56	59	42	38	33	24	35	39	36	21	32	24	27	67	62	40	28	30	29	23	18	4721·0

ard Deviation ·278 inches or 7·062 mm.

TABLE V. *Mean and Standard Deviation by Age of Head Breadth and Length in Inches and Millimetres.*

Age*	Means				Standard Deviations			
	Inches		Millimetres		Inches		Millimetres	
	Breadth	Length	Breadth	Length	Breadth	Length	Breadth	Length
4—7	5·65	7·14	143·51	181·35	·136	·237	3·45	6·02
8	5·72	7·27	145·29	184·66	·176	·228	4·47	5·79
9	5·76	7·21	146·30	183·13	·187	·223	4·72	5·66
10	5·75	7·22	146·05	183·39	·235†	·261	5·97	6·63
11	5·76	7·26	146·30	184·40	·180	·225	4·57	5·71
12	5·77	7·32	146·56	185·93	·179	·194	4·55	4·93
13	5·76	7·33	146·30	186·18	·187	·233	4·75	5·92
14	5·81	7·40	147·57	187·96	·184	·240	4·67	6·10
15	5·84	7·46	148·33	189·48	·194	·250	4·93	6·35
16	5·92	7·51	150·37	190·75	·190	·239	4·83	6·07
17	5·92	7·58	150·37	192·53	·196	·249	4·98	6·32
18	5·96	7·61	151·38	193·29	·195	·258	4·95	6·55
19	5·97	7·62	151·64	193·55	·218	·251	5·54	6·38
20	5·96	7·65	151·38	194·31	·190	·235	4·83	5·97
21	5·97	7·65	151·64	194·31	·215	·256	5·46	6·50
22	5·97	7·63	151·64	193·80	·214	·250	5·44	6·35
23	5·98	7·64	151·89	194·05	·203	·229	5·16	5·82
24	5·97	7·66	151·64	194·56	·211	·249	5·36	6·32
25	5·97	7·67	151·64	194·82	·236	·246	5·99	6·25
26	5·99	7·65	152·14	194·31	·216	·219	5·49	5·56
27	6·00	7·67	152·40	194·82	·204	·261	5·18	6·63
28	6·00	7·64	152·40	194·05	·197	·263	5·00	6·68
29	6·02	7·70	152·91	195·58	·220	·229	5·59	5·82
30	6·03	7·69	153·16	195·32	·214	·270	5·44	6·86
31	6·04	7·68	153·41	195·07	·193	·203	4·90	5·16
32	6·04	7·68	153·41	195·07	·226	·267	5·74	6·78
33	6·01	7·70	152·65	195·58	·225	·259	5·71	6·58
34	5·99	7·68	152·14	195·07	·216	·236	5·49	5·99
35	6·06	7·71	153·92	195·83	·241	·205	6·12	5·21
36	6·03	7·69	153·16	195·32	·172	·229	4·37	5·82
37	6·00	7·64	152·40	194·05	·155	·271	3·94	6·88
38	6·05	7·68	153·69	195·07	·188	·203	4·78	5·16
39	6·07	7·69	154·18	195·32	·226	·274	5·74	6·96
40	6·07	7·81	154·18	198·37	·195	·248	4·95	6·30
41	6·01	7·64	152·65	194·05	·199	·210	5·05	5·33
42	6·04	7·67	153·41	194·82	·186	·236	4·72	5·99
43	6·10	7·73	154·94	196·34	·214	·210	5·44	5·33
44	6·04	7·77	153·41	197·36	·246	·275	6·25	6·98
45	6·07	7·77	154·18	197·36	·213	·243	5·41	6·17
46	6·09	7·78	154·68	197·61	·189	·279	4·80	7·09
47—49	6·04	7·73	153·41	196·34	·234	·277	5·94	7·04
50—52	6·09	7·79	154·68	197·86	·220	·270	5·59	6·86
53—55	6·02	7·71	152·91	195·83	·243	·288	6·17	7·32
56—58	6·12	7·65	155·45	194·31	·223	·206	5·66	5·23
59—61	6·11	7·69	155·19	195·32	·192	·268	4·88	6·81
62—64	6·15	7·78	156·21	197·61	·220	·239	5·59	6·07
65—69	6·15	7·85	156·21	199·39	·246	·232	6·25	5·89
70—80	6·10	7·80	154·94	198·12	·251	·242	6·38	6·15

* Age has the following meaning: group 4—7 includes all those who are at least 4 but not 8; 8 signifies those who are 8 but not 9 and would therefore correspond to a central age of 8·5, and so on.

† When one extreme observation of the array for age 10·5 is omitted this becomes ·2099, the value used in plotting the standard deviations by years.

sight, but the female is slightly more variable than the male in response to sounds.

Tables III, IV, and V present the data upon which the curves of Diagrams I and II are based.

An inspection of the curves of means in Diagrams I and II indicate that there is an increase in the size of the skull from age 27 to age 66 at least. As growth is ordinarily considered to cease at about the former age the tendency observed calls for some comment. It may be due to the fact that for some reason the

TABLE VI.

Head Breadth and Head Length: Read from Curve by Ages.

Central Age	Inches		Millimetres		Central Age	Inches		Millimetres	
	Breadth	Length	Breadth	Length		Breadth	Length	Breadth	Length
4·5	5·55	7·09	140·97	180·08	*43·5*	6·07	7·71	154·18	195·83
5·5	5·59	7·11	141·98	180·59	*44·5*	6·07	7·72	154·18	196·09
6·5	5·64	7·13	143·25	181·10	*45·5*	6·07	7·72	154·18	196·09
7·5	5·68	7·16	144·27	181·86	*46·5*	6·07	7·72	154·18	196·09
8·5	5·72	7·18	145·29	182·37	*47·5*	6·08	7·72	154·43	196·09
9·5	5·75	7·21	146·05	183·13	*48·5*	6·08	7·73	154·43	196·34
10·5	5·76	7·24	146·30	183·89	*49·5*	6·08	7·73	154·43	196·34
11·5	5·76	7·27	146·30	184·66	*50·5*	6·09	7·73	154·68	196·34
12·5	5·77	7·31	146·56	185·67	*51·5*	6·09	7·74	154·68	196·59
13·5	5·78	7·35	146·81	186·69	*52·5*	6·09	7·74	154·68	196·59
14·5	5·81	7·40	147·57	187·96	*53·5*	6·10	7·74	154·94	196·59
15·5	5·84	7·45	148·33	189·23	*54·5*	6·10	7·74	154·94	196·59
16·5	5·89	7·51	149·60	190·75	*55·5*	6·10	7·75	154·94	196·85
17·5	5·94	7·58	150·87	192·53	*56·5*	6·11	7·75	155·19	196·85
18·5	5·96	7·61	151·38	193·29	*57·5*	6·11	7·75	155·19	196·85
19·5	5·97	7·63	151·64	193·80	*58·5*	6·11	7·76	155·19	197·10
20·5	5·97	7·64	151·64	194·05	*59·5*	6·11	7·76	155·19	197·10
21·5	5·97	7·65	151·64	194·31	*60·5*	6·12	7·76	155·45	197·10
22·5	5·98	7·65	151·89	194·31	*61·5*	6·12	7·76	155·45	197·10
23·5	5·98	7·65	151·89	194·31	*62·5*	6·12	7·77	155·45	197·36
24·5	5·98	7·66	151·89	194·56	*63·5*	6·13	7·77	155·70	197·36
25·5	5·99	7·66	152·14	194·56	*64·5*	6·13	7·77	155·70	197·36
26·5	5·99	7·66	152·14	194·56	*65·5*	6·13	7·78	155·70	197·61
27·5	6·00	7·67	152·40	194·82	*66·5*	6·13	7·78	155·70	197·61
28·5	6·01	7·67	152·65	194·82	*67·5*	6·13	7·78	155·70	197·61
29·5	6·01	7·67	152·65	194·82	*68·5*	6·13	7·78	155·70	197·61
30·5	6·02	7·68	152·91	195·07	*69·5*	6·13	7·79	155·70	197·86
31·5	6·02	7·68	152·91	195 07	*70·5*	6 13	7·79	155·70	197·86
32·5	6·03	7·68	153·16	195·07	*71·5*	6·12	7·79	155·45	197·86
33·5	6·03	7·69	153·16	195·32	*72·5*	6·11	7·80	155·19	198·12
34·5	6·04	7·69	153·41	195·32	*73·5*	6·11	7·80	155·19	198·12
35·5	6·04	7·69	153·41	195·32	*74·5*	6·10	7·80	154·94	198·12
36·5	6·04	7·69	153·41	195·32	*75·5*	6·09	7·81	154·68	198·37
37·5	6·05	7·70	153·67	195·58	*76·5*	6·08	7·81	154·43	198·37
38·5	6·05	7·70	153·67	195·58	*77·5*	6·08	7·81	154·43	198·37
39·5	6·05	7·70	153·67	195·58	*78·5*	6·07	7·82	154·18	198·63
40·5	6·06	7·70	153·92	195·58	*79·5*	6·06	7·82	153·92	198·63
41·5	6·06	7·71	153·92	195·83	*80·5*	6·05	7·82	153·67	198·63
42·5	6·06	7·71	153·92	195·83					

larger headed people tended to present themselves in greater numbers for examination. Or the result may be due to the effect of selection by death, the smaller headed people being possibly less robust on the average and so tending to die at a younger age. If, however, neither of these suppositions be accepted as explaining adequately the upward trend of the curves, and that trend is based on considerable numbers, then it seems necessary to conclude that the skull continues to increase in size up to quite advanced ages*.

In Table VI there are given by ages the values for head breadth and head length read from the curves fitted to the computed means and plotted in Diagrams I and II. The standard deviations of head breadth as read by ages from the curve fitted to the computed standard deviations and plotted in Diagram I will be found in Table VII. The standard deviation of head length read from the fitted line plotted in Diagram II, as has already been mentioned, is ·244 inches for all ages.

TABLE VII.

Standard Deviation of Head Breadth: read from Curve by Ages.

Central Age	Inches	Millimetres	Central Age	Inches	Millimetres	Central Age	Inches	Millimetres
4·5	·068	1·73	*30·5*	·211	5·36	*56·5*	·222	5·64
5·5	·103	2·62	*31·5*	·211	5·36	*57·5*	·223	5·66
6·5	·134	3·40	*32·5*	·212	5·38	*58·5*	·223	5·66
7·5	·162	4·11	*33·5*	·212	5·38	*59·5*	·224	5·69
8·5	·178	4·52	*34·5*	·213	5·41	*60·5*	·224	5·69
9·5	·188	4·78	*35·5*	·214	5·44	*61·5*	·225	5·71
10·5	·189	4·80	*36·5*	·214	5·44	*62·5*	·225	5·71
11·5	·187	4·75	*37·5*	·214	5·44	*63·5*	·226	5·74
12·5	·184	4·67	*38·5*	·215	5·46	*64·5*	·226	5·74
13·5	·184	4·67	*39·5*	·215	5·46	*65·5*	·227	5·77
14·5	·185	4·70	*40·5*	·215	5·46	*66·5*	·228	5·79
15·5	·188	4·78	*41·5*	·215	5·46	*67·5*	·229	5·82
16·5	·192	4·88	*42·5*	·216	5·49	*68·5*	·230	5·84
17·5	·195	4·95	*43·5*	·217	5·51	*69·5*	·230	5·84
18·5	·199	5·05	*44·5*	·217	5·51	*70·5*	·230	5·84
19·5	·202	5·13	*45·5*	·218	5·54	*71·5*	·229	5·82
20·5	·204	5·18	*46·5*	·219	5·56	*72·5*	·228	5·79
21·5	·206	5·23	*47·5*	·219	5·56	*73·5*	·227	5·77
22·5	·207	5·26	*48·5*	·220	5·59	*74·5*	·226	5·74
23·5	·208	5·28	*49·5*	·220	5·59	*75·5*	·224	5·69
24·5	·209	5·31	*50·5*	·221	5·61	*76·5*	·222	5·64
25·5	·209	5·31	*51·5*	·221	5·61	*77·5*	·219	5·56
26·5	·210	5·33	*52·5*	·221	5·61	*78·5*	·216	5·49
27·5	·210	5·33	*53·5*	·221	5·61	*79·5*	·213	5·41
28·5	·210	5·33	*54·5*	·222	5·64	*80·5*	·211	5·36
29·5	·210	5·33	*55·5*	·222	5·64			

Tables VIII to XIII inclusive present the data concerning the correlation of head measurements and cephalic index with reaction times to both sight and sound.

* Hatters have claimed that the heads of their customers increase in size throughout life.

TABLE VIII.

Galton's Anthropometric Data, Second Laboratory Series, Males. Reaction Time to Sight and Head Breadth both Corrected for Age.

Central Values. Head Breadth in Inches.

Central Values. Reaction Time to Sight in $\frac{1}{100}$".	5·105	5·205	5·305	5·405	5·505	5·605	5·705	5·805	5·905	6·005	6·105	6·205	6·305	6·405	6·505	6·605	6·705	6·805	6·905	7·005	7·105	7·205	7·305	7·405	7·505	7·605	7·705	7·805	Totals
5·995	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
7·995	—	—	—	—	—	—	—	3	—	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
9·995	1	—	—	—	1	3	8	15	15	15	29	15	6	3	3	—	—	1	—	—	—	—	—	—	—	—	—	—	115
11·995	—	—	—	—	1	2	2	14	18	21	30	24	14	9	1	4	1	—	—	—	—	—	—	—	—	—	—	—	141
13·995	—	—	—	—	—	6	14	27	42	62	59	46	37	15	8	4	2	—	1	—	—	—	—	—	—	—	—	—	323
15·995	1	—	1	—	5	18	54	93	145	197	223	158	101	50	23	5	2	—	1	—	—	—	—	—	—	—	—	—	1077
17·995	—	—	1	2	13	20	37	112	183	265	312	161	115	48	24	14	4	4	—	1	—	—	—	—	—	—	—	1	1317
19·995	—	1	3	5	13	24	68	145	237	241	263	221	114	66	23	15	4	1	—	—	—	—	—	—	—	—	—	—	1444
21·995	—	—	—	2	5	11	27	74	83	70	106	71	43	30	12	4	—	—	1	1	—	—	—	—	—	—	—	—	540
23·995	—	—	—	1	2	9	15	29	45	63	59	43	36	23	8	2	—	—	—	—	—	—	—	—	—	—	—	—	335
25·995	—	—	1	—	4	—	4	19	28	30	23	21	14	3	2	—	—	1	—	—	—	—	—	—	—	—	—	—	150
27·995	—	—	—	—	—	1	1	5	9	9	11	6	—	1	—	2	—	—	—	—	—	—	—	—	—	—	—	—	45
29·995	—	—	—	—	—	4	5	6	6	6	11	2	5	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	47
31·995	—	—	—	1	—	—	—	—	3	2	3	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11
33·995	—	—	—	—	—	—	—	1	1	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	4
35·995	—	—	—	—	—	—	—	1	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
37·995	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
39·995	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
41·995	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
43·995	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Totals	2	1	6	11	44	99	235	546	815	985	1132	770	487	249	106	50	13	7	3	2	—	—	—	—	—	—	—	1	5564

TABLE IX.

Galton's Anthropometric Data, Second Laboratory Series, Males. Reaction Time to Sight and Head Length, both Corrected for Age.

Central Values. Head Length in Inches.

Central Values. Reaction Time to Sight in $\frac{1}{100}$".	6·805	6·905	7·005	7·105	7·205	7·305	7·405	7·505	7·605	7·705	7·805	7·905	8·005	8·105	8·205	8·305	8·405	8·505	8·605	Totals
5·995	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
7·995	—	—	—	—	—	1	—	1	1	—	—	—	—	—	—	—	—	—	—	3
9·995	—	—	1	2	1	5	5	10	10	12	12	7	6	4	1	—	—	—	—	76
11·995	—	—	—	1	1	1	5	9	10	15	15	5	8	6	4	2	1	—	—	83
13·995	—	—	2	4	6	10	23	29	30	49	39	27	19	9	7	1	—	—	—	255
15·995	—	—	4	2	14	37	67	115	131	138	145	121	71	39	17	6	1	2	—	910
17·995	—	5	4	11	22	43	76	143	191	201	177	146	83	52	22	11	1	2	—	1190
19·995	2	1	5	13	37	58	122	148	176	196	215	138	81	63	31	9	3	—	2	1300
21·995	—	1	1	7	11	25	41	53	76	56	78	49	28	25	8	5	—	1	—	465
23·995	—	—	1	—	7	10	24	22	58	45	42	24	19	11	5	1	—	1	—	270
25·995	—	—	—	3	3	5	13	13	13	12	14	5	5	6	2	—	—	—	—	94
27·995	—	—	1	—	1	—	1	5	5	2	4	2	2	2	—	—	—	—	—	25
29·995	—	—	—	—	1	—	—	—	1	4	2	1	2	1	—	—	—	—	—	12
31·995	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	2
33·995	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
35·995	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
37·995	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
39·995	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
41·995	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
43·995	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
Totals	2	7	19	43	104	196	378	550	702	731	745	525	324	218	97	35	6	6	2	4690

TABLE X.

Galton's Anthropometric Data, Second Laboratory Series, Males. Cephalic Index and Reaction Time to Sight, the latter Corrected for Age.

Central Values. Cephalic Index.

Central Values. Reaction Time to Sight in $\frac{1}{166}$".	67·05	68·05	69·05	70·05	71·05	72·05	73·05	74·05	75·05	76·05	77·05	78·05	79·05	80·05	81·05	82·05	83·05	84·05	85·05	86·05	87·05	88·05	89·05	90·05	91·05	92·05	93·05	94·05	95·05	96·05	97·05	98·05	Totals
5·995	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1
7·995	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	3
9·995	—	—	—	—	—	—	—	5	9	9	7	7	14	10	5	5	4	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	76
11·995	—	—	—	—	1	—	3	2	8	7	13	17	3	13	9	4	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	83
13·995	—	—	—	—	3	2	4	6	15	21	35	35	45	27	22	17	12	2	4	3	2	—	—	—	—	—	—	—	—	—	—	—	255
15·995	—	—	2	1	4	5	19	48	70	96	123	151	130	95	49	48	34	21	6	6	1	—	1	—	—	—	—	—	—	—	—	—	910
17·995	—	—	2	—	4	10	41	60	90	118	151	171	151	133	90	65	41	32	13	6	7	1	1	1	—	—	—	—	—	1	—	1	1190
19·995	—	4	1	3	5	21	26	67	107	140	169	177	157	146	109	65	42	32	9	14	2	1	2	1	—	—	—	—	—	—	—	—	1300
21·995	—	1	—	1	1	9	11	24	42	52	54	59	54	58	33	26	12	16	4	2	1	3	2	—	—	—	—	—	—	—	—	—	465
23·995	—	—	—	—	1	2	7	12	13	28	24	37	42	29	30	19	14	8	3	1	—	—	—	—	—	—	—	—	—	—	—	—	270
25·995	1	—	—	—	1	1	3	3	6	8	11	12	17	15	7	6	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	94
27·995	—	—	—	—	—	—	2	1	3	2	3	2	3	2	3	—	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25
29·995	—	—	—	—	1	—	—	1	1	3	1	2	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12
31·995	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
33·995	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
35·995	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
37·995	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
39·995	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
41·995	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
43·995	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Totals	1	5	5	5	21	51	116	230	364	484	591	671	619	531	358	255	168	114	40	33	13	5	6	2	—	—	—	—	—	1	—	1	4690

TABLE XI.

Galton's Anthropometric Data, Second Laboratory Series, Males. Reaction Time to Sound and Head Breadth, both Corrected for Age.

Central Values. Head Breadth in Inches.

Central Values. Reaction Time to Sound in $\frac{1}{100}$".	5·105	5·205	5·305	5·405	5·505	5·605	5·705	5·805	5·905	6·005	6·105	6·205	6·305	6·405	6·505	6·605	6·705	6·805	6·905	7·005	7·105	7·205	7·305	7·405	7·505	7·605	7·705	7·805	Totals
3·995	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
5·995	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
7·995	—	—	—	—	—	—	—	—	—	2	—	—	1	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	6
9·995	—	—	—	—	—	4	6	21	18	25	45	28	18	6	7	1	—	—	—	—	—	—	—	—	—	—	—	—	179
11·995	2	—	1	—	4	8	38	67	96	152	165	100	85	30	20	10	3	—	1	—	—	—	—	—	—	—	—	—	782
13·995	—	—	—	1	14	31	47	132	203	290	322	229	133	68	20	11	5	3	1	—	—	—	—	—	—	—	—	—	1510
15·995	—	—	4	5	15	28	67	173	276	306	343	227	143	82	25	17	1	1	—	1	—	—	—	—	—	—	—	1	1715
17·995	—	—	—	3	4	13	39	78	113	121	131	102	55	35	11	5	3	2	—	—	—	—	—	—	—	—	—	—	715
19·995	—	1	—	1	2	8	27	48	74	63	75	57	32	18	15	2	1	—	1	1	—	—	—	—	—	—	—	—	426
21·995	—	—	—	—	—	3	4	8	12	13	26	10	8	3	2	2	—	—	—	—	—	—	—	—	—	—	—	—	91
23·995	—	—	—	1	2	4	4	10	18	7	14	8	6	4	3	1	—	1	—	—	—	—	—	—	—	—	—	—	83
25·995	—	—	1	—	1	—	2	1	3	3	7	5	3	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	28
27·995	—	—	—	—	1	—	—	4	—	1	3	—	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	12
29·995	—	—	—	—	1	—	—	1	2	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
31·995	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
33·995	—	—	—	—	—	—	—	1	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
35·995	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
37·995	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
39·995	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Totals	2	1	6	11	44	99	234	545	815	985	1133	769	488	249	106	50	13	7	3	2	—	—	—	—	—	—	—	1	5563

TABLE XII.

Galton's Anthropometric Data, Second Laboratory Series, Males. Reaction Time to Sound and Head Length, both Corrected for Age.

Central Values. Head Length in Inches.

Central Values. Reaction Time to Sound in $\frac{1}{100}$".	6·805	6·905	7·005	7·105	7·205	7·305	7·405	7·505	7·605	7·705	7·805	7·905	8·005	8·105	8·205	8·305	8·405	8·505	8·605	Totals
3·995	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
5·995	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1
7·995	—	—	—	—	—	—	—	—	2	1	1	—	—	—	—	—	—	—	—	4
9·995	—	—	—	2	2	6	13	17	16	21	23	19	6	8	3	1	—	—	—	137
11·995	—	1	—	1	11	25	54	91	95	129	104	75	62	34	16	6	—	—	1	705
13·995	—	1	7	12	23	53	100	166	197	215	227	159	102	67	31	9	3	3	—	1375
15·995	2	4	7	14	32	67	133	170	243	235	227	166	99	64	27	13	2	2	1	1508
17·995	—	1	2	6	17	24	48	66	111	66	99	66	29	27	15	3	1	—	—	581
19·995	—	—	2	6	13	14	22	30	24	44	49	31	20	12	4	3	—	—	—	274
21·995	—	—	1	—	4	3	1	7	9	10	9	6	1	2	1	—	—	1	—	55
23·995	—	—	—	2	2	1	4	1	3	6	4	1	3	2	—	—	—	—	—	29
25·995	—	—	—	—	—	2	—	1	—	2	1	—	1	2	—	—	—	—	—	9
27·995	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	2
29·995	—	—	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	3
31·995	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
33·995	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	2
Totals	2	7	19	43	104	196	378	550	701	730	744	524	324	218	97	35	6	6	2	4686

TABLE XIII.

Galton's Anthropometric Data, Second Laboratory Series, Males. Cephalic Index and Reaction Time to Sound, the latter Corrected for Age.

Central Values. Cephalic Index.

Central Values. Reaction Time to Sound in $\frac{1}{100}''$.	6·705	6·805	6·905	7·005	7·105	7·205	7·305	7·405	7·505	7·605	7·705	7·805	7·905	8·005	8·105	8·205	8·305	8·405	8·505	8·605	8·705	8·805	8·905	9·005	9·105	9·205	9·305	9·405	9·505	9·605	9·705	9·805	Totals
3·995	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
5·995	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
7·995	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
9·995	—	—	—	—	2	2	4	4	9	13	15	25	18	15	8	8	7	2	1	2	2	—	—	—	—	—	—	—	—	—	—	—	137
11·995	—	1	2	1	3	6	14	40	46	61	91	120	91	77	58	39	29	13	7	3	1	—	2	—	—	—	—	—	—	—	—	—	705
13·995	1	—	1	2	5	14	36	71	121	136	175	197	177	160	92	75	49	36	7	13	4	1	1	1	—	—	—	—	—	—	—	—	1375
15·995	—	2	2	2	6	12	37	71	114	161	194	210	197	183	126	75	46	38	14	7	5	2	1	1	—	—	—	—	—	1	—	1	1508
17·995	—	2	—	—	2	9	12	31	46	64	79	72	81	59	40	37	19	15	7	4	—	1	1	—	—	—	—	—	—	—	—	—	581
19·995	—	—	—	—	3	5	8	10	21	38	27	36	40	23	23	14	10	8	2	3	1	1	1	—	—	—	—	—	—	—	—	—	274
21·995	—	—	—	—	—	1	1	3	3	5	5	6	7	9	8	2	3	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	55
23·995	—	—	—	—	—	2	2	—	2	4	3	2	4	2	2	3	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	29
25·995	—	—	—	—	—	—	1	—	1	1	—	2	—	1	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9
27·995	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
29·995	—	—	—	—	—	—	—	—	—	—	—	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
31·995	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
33·995	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Totals	1	5	5	5	21	51	116	230	363	483	590	671	618	531	358	255	168	114	40	33	13	5	6	2	—	—	—	—	—	1	—	1	4686

The measures of relationship determined from the tables just mentioned are set forth in Table XIV.

TABLE XIV.

Constants of Relationship.

	r	$\eta_{t.h}$*	$\eta^2_{t.h}$	$\bar{\eta}^2_{t.h}$
Head Breadth : Reaction Time to Sight	$-\cdot0420\pm\cdot00903$	·0743	·005520	$\cdot003595\pm\cdot00077$
Head Length : " " "	$-\cdot0337\pm\cdot00984$	·0677	·004583	$\cdot003838\pm\cdot00086$
Cephalic Index : " " "	$-\cdot0079\pm\cdot00984$	·0828	·006856	$\cdot005330\pm\cdot00101$
Head Breadth : Reaction Time to Sound	$-\cdot0486\pm\cdot00902$	·0929	·008630	$\cdot003595\pm\cdot00077$
Head Length : " " "	$-\cdot0526\pm\cdot00983$	·0862	·007430	$\cdot003841\pm\cdot00086$
Cephalic Index : " " "	$-\cdot0049\pm\cdot00985$	·0708	·005013	$\cdot005335\pm\cdot00102$

It will be observed that the correlation coefficients are all negative and very small. Having regard to their probable errors all the coefficients, except those for cephalic index and reaction times to both sight and sound, may be considered to differ significantly from zero. In each case the correlation ratio is quite small and in only two cases, namely for head breadth and reaction time to sound and for head length and reaction time to sound, is the difference between η^2 and $\bar{\eta}^2$† significant when the probable errors of $\bar{\eta}^2$ are taken into account. While r and η are distinctly too small to be of any value for prognostic purposes, they do indicate that there is a very slight tendency indeed for the larger headed individuals to exhibit shorter reaction times. Similarly, the results for cephalic index and reaction time to both sight and sound indicate that there is a very slight tendency for individuals with rounder heads to show the shorter reaction time, but the correlations are not significant having regard to their probable errors.

From the analysis of the data here considered it may be concluded that for males the degree of association between head breadth and head length and reaction time to both sight and sound in each instance is too small to be of any service for purposes of estimation. Or, as far as the mental element in reaction time is concerned, the view taken by previous biometric writers is confirmed, namely that the size and shape of the head have little if any association with the working of the brain.

* $\eta_{t.h}$ means the correlation ratio of reaction time on the corresponding head measurements or index.

† $\bar{\eta}^2$ is the figure that would be obtained if there were no correlation.

$\bar{\eta}^2=\dfrac{C-1}{N}$ in which C refers to the number of columns containing observations of the correlation table used in calculating η. The probable error of $\bar{\eta}^2=\cdot67449\,\sigma_{\bar{\eta}^2}$ has been taken

$$=\cdot67449\sqrt{\frac{2\bar{\eta}^2(1-\bar{\eta}^2)}{N+1}}$$

MISCELLANEA.

I. On Romanovsky's Generalised Frequency Curves.

By JOHN WISHART, M.A., B.Sc.

In *Biometrika*, Vol. XVI. pp. 106—116, Professor Romanovsky has shown how the Pearson Frequency Curves may be generalised in much the same way as the normal curve has been generalised by Thiele and Charlier. In particular he is able to write his equation to the frequency curve as

$$y = A_0 u_0 + A_1 u_1 + A_2 u_2 + \dots \quad \dots\dots\dots\

represents frequency distributions whose moments are such that the relation $2\beta_2-3\beta_1-6=0$ holds, or, in other words, whose representative points on the β_1, β_2 diagram lie along the line $2\beta_2-3\beta_1-6=0$. Now suppose we have a distribution whose β_1, β_2 nearly satisfy this relation but not quite, so that the representative point falls close to the Type III line. Then it is reasonable to suppose that fitting the distribution with a Type III curve will produce a rough approximation to the actual frequencies. Again, bringing in the fourth moment, and using it to determine the additional constant in the second term of the Generalised Type III curve, ought to improve the fit and give us as good a description of the distribution as fitting in the first instance the appropriate Pearson curve by the aid of four moments. Such an application of the method under discussion has, in fact, been made, not in the first instance to test Romanovsky's method, but as part of a general enquiry into determining approximately the probability integrals of certain Type I curves where one index, say p, is low, but the other, q, is high, so that the integral in question falls outside the *Tables of the Incomplete Beta-function*, which, it is hoped, will shortly be published.

Let, then, $p=4$ and $q=49$ in equation (2) and we shall consider the frequency distribution whose equation is

$$y=y_0x^3(1-x)^{48} \quad \text{.....(4).}$$

Whole numbers are taken for p and q for ease in checking, but no loss in generality is suffered by so doing.

The constants of this curve are, by the ordinary formulae,

$$\beta_1=\cdot73773,$$

$$\beta_2=3\cdot97969,$$

so we have $$2\beta_2-3\beta_1-6=-\cdot25381,$$

that is, the point $\beta_1\beta_2$ lies close up to the Type III line. Now we have

$$I_x(4,49)=\frac{\Gamma(53)}{\Gamma(4)\,\Gamma(49)}\int_0^x x^3(1-x)^{48}\,dx \quad \text{.....(5),}$$

where $I_x(p, q)$ is the notation used for the Probability Integral of Type I. This was then worked out for two typical values of x, one on either side of the mode, by interpolating into the unpublished *Tables of the Incomplete Beta-function*, and checking by a binomial expansion.

Thus for $x=\cdot027\ 7159$ we have: $I_x(4, 49)=\cdot055\ 8876$,

and for $x'=\cdot075\ 4717$ (mean) we have: $I_{x'}(4, 49)=\cdot558\ 8886$.

So just over half the total area of the curve is contained between the corresponding ordinates, the curve, and the axis of x. It remains now to compare these values with those found by fitting a Generalised Type III curve.

The equation is

$$y=y_0\left(1+\frac{x}{a}\right)^{\nu a}e^{-\nu x}\left[1+\sum_{k=4}^{\infty}\frac{S_k}{k\,!\,(a+1)_k S_0}\phi_k\right] \quad \text{.....(6),}$$

where y_0, a, and ν are the constants of the ordinary Type III curve and $S_0=N$ the total population, while $S_k=\int_{-a}^{\infty}y\phi_k\,dx$, ϕ_k being the following expression

$$\phi_k=(a+1)_k-\frac{k}{1\,!}(a+2)_k\,\nu\,(a+x)+\frac{k(k-1)}{2\,!}(a+3)_k\,\nu^2(a+x)^2-\ldots+(-1)^k\nu^k(a+x)^k, \quad a=\nu a$$

$$\text{.....(7),}$$

where $(a+i)_k$ is an abridgment for $(a+i)\,(a+i+1)\ldots(a+k)$.

Transferring to the mean $x=\frac{1}{\nu}$ and writing $a'=a+\frac{1}{\nu}=\frac{a+1}{\nu}$ we have

$$y=y_0'(a'+X)^a e^{-\nu X}\left[1+\sum_{k=4}^{\infty}\frac{S_k'}{k\,!\,(a+1)_k S_0}\phi_k'\right] \quad \text{.....(8),}$$

where S_k', ϕ_k' are the expressions S_k, ϕ_k with a' substituted for a.

It would be cumbersome to retain all the terms of the series in the reduction. We shall therefore confine ourselves to consideration of the term in S_4 only, when the mode of formation of the terms will become evident, and the succeeding terms in S_5, S_6, etc., can then be written down straight off.

Perhaps the best way to evaluate the S's is to make use of the following simple reduction formulae for the polynomials ϕ_k.

ϕ_k being defined by equation (7), we have

$$\phi_{k+1}=(\phi_1+k)\,\phi_k-k!\,\nu\,(a+x)\left\{1+\frac{\phi_1}{1!}+\frac{\phi_2}{2!}+\frac{\phi_3}{3!}+\ldots+\frac{\phi_{k-1}}{(k-1)!}\right\},$$

or

$$\phi_{k+1}=(\phi_1+2k)\,\phi_k-k\,(a+k)\,\phi_{k-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(9).$$

Replacing a by a' and noting that

$$\int_{-a'}^{\infty} y\phi_1'\,dX=\int_{-a'}^{\infty} y\phi_2'\,dX=\int_{-a'}^{\infty} y\phi_3'\,dX=0,$$

while

$$\int_{-a'}^{\infty} y\,dX=S_0,\quad \nu^2\mu_2=a+1,\quad \nu^3\mu_3=2\,(a+1),$$

we get

$$\frac{S_4}{S_0}=\nu^4\mu_4-3\,(a+1)\,(a+3) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(10),$$

as we might have expected at the outset, for the fourth moment of the Type III curve (3) is $\frac{3\,(a+1)\,(a+3)}{\nu^4}$, so that the first coefficient of the Romanovsky expansion is proportional to the difference between the Type III fourth moment and the fourth moment of the actual distribution we are fitting. If these fourth moments had been equal, i.e. if the β_1, β_2 point had fallen exactly on the Type III line, we should have had $S_4=0$ along with S_1, S_2 and S_3, and then the first coefficient occurring, S_5, would have been proportional to the difference between the Type III fifth moment and the fifth moment of the distribution. Similarly, if any number of moments of our selected frequency distribution were equal to their Type III values, a corresponding number of terms of the Series (8) would vanish.

To proceed: the value of $\frac{S_4}{S_0}$ is determined from (10) knowing a and ν by finding the fourth moment of the curve (4). Introducing the value of ϕ_4 from (7) we have to this order of approximation, when the right-hand side of (8) as now abridged is expanded

$$y=y_0'\left[(a'+X)^a\,e^{-\nu X}+c_1\,(a'+X)^a\,e^{-\nu X}-c_2\,(a'+X)^{a+1}\,e^{-\nu X}+\ldots+c_5\,(a'+X)^{a+4}\,e^{-\nu X}\right],$$

where

$$c_1=\frac{S_4}{4!\,S_0},\quad c_2=\frac{4\nu\,S_4}{4!\,(a+1)\,S_0},\quad c_3=\frac{6\nu^2\,S_4}{4!\,(a+1)_2\,S_0},\quad c_4=\frac{4\nu^3\,S_4}{4!\,(a+1)_3\,S_0},\quad c_5=\frac{\nu^4\,S_4}{4!\,(a+1)_4\,S_0}.$$

To get this into a form suitable for integration, let $z=\nu\,(a'+X)$. Then

$$y=y_0''\left[z^a\,e^{-z}+\frac{S_4}{4!\,S_0}\left\{z^a\,e^{-z}-\frac{4}{a+1}\,z^{a+1}\,e^{-z}+\frac{6}{(a+1)_2}\,z^{a+2}\,e^{-z}-\frac{4}{(a+1)_3}\,z^{a+3}\,e^{-z}+\frac{1}{(a+1)_4}\,z^{a+4}\,e^{-z}\right\}\right]$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(11).$$

Now the Probability Integral of Type III is denoted by $I\,(u,\,a)$, where

$$I\,(u,\,a)=\frac{1}{\Gamma\,(a+1)}\int_0^{u\sqrt{a+1}} e^{-z}\,z^a\,dz.$$

Equation (11) is the frequency curve which, by a suitable choice of the constants, can be made to have the same first four moments as any distribution which it is desired to fit. It is of the form

$$y=y_0''\,z^a\,e^{-z}\,(b_0+b_1z+b_2z^2+b_3z^3+b_4z^4).$$

The total area of this curve is

$$\int_0^{\infty} y\,dz=y_0''\,\Gamma\,(a+1)\left[1+\frac{S_4}{4!\,S_0}\,(1-4+6-4+1)\right]$$
$$=y_0''\,\Gamma\,(a+1),$$

i.e. it has the same total area as the curve from which it is derived. Hence the Probability Integral of this curve, or the ratio of the area up to any ordinate z to the total area

$$= I\left(\frac{z}{\sqrt{a+1}}, a\right) + \frac{S_4}{4!\,S_0} \times \left(I_1 - 4I_2 + 6I_3 - 4I_4 + I_5\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots (12),$$

where, for simplicity, we have put I_s for $I\left(\frac{z}{\sqrt{a+s}}, a+s-1\right)$.

The first term is the ordinary Type III Probability Integral, with the same first three moments as the distribution under consideration, and should provide a rough approximation to the Type I Probability Integrals we are seeking. The rest consists of a simple function of five such Probability Integrals, going up by one at a time. They can all be got from the *Tables of the Incomplete Gamma-function*, and so there is nothing but the labour of undertaking the necessary interpolations to stand in the way of a complete determination of the value of (12).

The simple law of formation of the terms in the expression deduced from (8) is now apparent, and without further proof the full value of the Probability Integral of the Romanovsky Generalised Type III curve can now be given. We have:

$$I_R = I_1 + \frac{S_4}{4!\,S_0} \times (I_1 - 4I_2 + 6I_3 - 4I_4 + I_5) + \frac{S_5}{5!\,S_0} \times (I_1 - 5I_2 + 10I_3 - 10I_4 + 5I_5 - I_6) + \ldots$$

$$+ \frac{S_k}{k!\,S_0} \times \left(I_1 - kI_2 + \frac{k(k-1)}{1.2} I_3 - \frac{k(k-1)(k-2)}{1.2.3} I_4 + \ldots + (-1)^k I_{k+1}\right) + \ldots \quad \ldots\ldots (13);$$

$\frac{S_4}{S_0}$ has already been given (see equation (10)) and we have by the aid of (9)

$$\frac{S_5}{S_0} = -8(a+1)(5a+17) + 20\nu^4\mu_4 - \nu^5\mu_5 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (14),$$

$$\frac{S_6}{S_0} = 10(a+1)(3a^2 - 28a - 151) + 15(19 - a)\nu^4\mu_4 - 30\nu^5\mu_5 + \nu^6\mu_6 \ldots\ldots\ldots\ldots (15).$$

Note: if we substitute the Type III fourth moment for μ_4 in (14) we have

$$\frac{S_5}{S_0} = 4(a+1)(5a+11) - \nu^5\mu_5,$$

the actual Type III fifth moment being $\frac{4(a+1)(5a+11)}{\nu^5}$. Again the substitution for μ_4 and μ_5 of their Type III values in (15) gives us

$$\frac{S_6}{S_0} = \nu^6\mu_6 - 5(a+1)(3a^2 + 32a + 53),$$

the part on the right, when divided by ν^6, being the Type III sixth moment. This bears out what was said earlier.

We shall now apply our result to the example we have chosen. By the aid of the relations given by Professor Pearson in *Phil. Trans.* Vol. 186A, p. 368, we find

$$\nu = \frac{2\mu_2}{\mu_3} = \frac{583}{9},$$

$$a + 1 = \nu a' = \frac{4}{\beta_1} = 5{\cdot}422\ 0393,$$

$$\nu^4\mu_4 = 116{\cdot}996\ 994\ 022,$$

$$\nu^5\mu_5 = 674{\cdot}377\ 108\ 55,$$

$$\nu^6\mu_6 = 6150{\cdot}543\ 559\ 85,$$

$$\frac{S_4}{4!\,S_0} = -{\cdot}155\ 4489,$$

$$\frac{S_5}{5!\,S_0} = -{\cdot}257\ 4452,$$

$$\frac{S_6}{6!\,S_0} = -{\cdot}301\ 4588.$$

We have to remember that the curve (11) does not start at the same point of the x-axis as the curve (4) with which we are comparing it. The two means coincide, but the distance between the start of the two curves is

$$x=\frac{p(p+1)}{(p+q+1)(q-p)}=-\cdot008\,2305,$$

while the relation between the x of the Type I curve and the u of the generalised Type III is

$$u=\frac{x}{\sigma}=\frac{x}{\cdot035\,9464}.$$

To find then the values of the probability integrals corresponding to the results obtained for the Type I curve, we require in the first instance, i.e. for I_1, to interpolate for $a=4\cdot422\,0393$ and for the following values of u:

$$u_1=\frac{\cdot0277\,159+\cdot0082\,305}{\cdot0359\,464}=1\cdot0$$

$$u_1'=\frac{\cdot0754\,717+\cdot0082\,305}{\cdot0359\,464}=2\cdot328\,5273.$$

We find $I(u_1, a)=\cdot0577\,460$, $I_x(p, q)=\cdot0558\,876$,
$I(u_1', a)=\cdot5571\,433$, $I_{x'}(p, q)=\cdot5588\,886$.

So that fitting our Type I curve with a Type III curve having the same first three moments has produced a fair measure of agreement in the results, an agreement which we may expect to become greater as the ratio of the indices p and q grows larger. Our example was chosen so as to come within that portion of the *Tables of the Incomplete Beta-Function* which had been computed.

To obtain the second, third and fourth approximations to the generalised curve (which is as far as we shall proceed) we have the following systems for u and u':

$$u_2=\frac{z}{\sqrt{a+2}}=\sqrt{\frac{a+1}{a+2}},\quad u_2'=\frac{z'}{\sqrt{a+2}}=\frac{a+1}{\sqrt{a+2}},$$

$$u_3=\sqrt{\frac{a+1}{a+3}},\quad u_3'=\frac{a+1}{\sqrt{a+3}}\text{ and so on.}$$

We then have on interpolating

$$\begin{aligned}
I_1&=\cdot057\,7460, & I_1'&=\cdot557\,1433,\\
I_2&=\cdot019\,6985, & I_2'&=\cdot388\,4253,\\
I_3&=\cdot005\,9030, & I_3'&=\cdot245\,9791,\\
I_4&=\cdot001\,5749, & I_4'&=\cdot141\,9176,\\
I_5&=\cdot000\,3783, & I_5'&=\cdot074\,9234,\\
I_6&=\cdot000\,0826, & I_6'&=\cdot036\,3708,\\
I_7&=\cdot000\,0166, & I_7'&=\cdot016\,3140.
\end{aligned}$$

The formula used for Interpolation was Casus III Mid-side Bivariate Interpolation Formula. See Introduction, *Tables of the Incomplete* Γ*-function*, p. xii.

Finally, taking these values in conjunction with those found for S_4, S_5 and S_6, we have, denoting the Romanovsky generalised Type III Probability Integral by $I_R(u, p)$,

$$\begin{aligned}
I_R(1\cdot0,\ 4\cdot4220393)&=\cdot057\,7460+(-\cdot155\,4489)(\cdot008\,4487)\\
&\quad+(-\cdot257\,4452)(\cdot004\,3434)+(-\cdot301\,4588)(\cdot001\,7975)\\
&=\cdot057\,7460-\cdot001\,3133-\cdot001\,1182-\cdot000\,5419,
\end{aligned}$$

so that the successive approximations are

$$\begin{aligned}
&\cdot057\,7460,\\
&\cdot056\,4327,\\
&\cdot055\,3145,\\
&\cdot054\,7726,
\end{aligned}$$

while the true value $I_x(4, 49)=\cdot055\,8876$.

On the other side of the mode we have

$$I_R(2{\cdot}328\ 5273,\ 4{\cdot}422\ 0393) = {\cdot}557\ 1433 + (-{\cdot}155\ 4489)(-{\cdot}013\ 4303) + (-{\cdot}257\ 4452)(-{\cdot}006\ 1220) + (-{\cdot}301\ 4588)(-{\cdot}000\ 1338)$$
$$= {\cdot}557\ 1433 + {\cdot}002\ 0877 + {\cdot}001\ 5761 + {\cdot}000\ 0403,$$

the successive results being

$${\cdot}557\ 1433,$$
$${\cdot}559\ 2310,$$
$${\cdot}560\ 8071,$$
$${\cdot}560\ 8474,$$

while the true value $I_{x'}(4, 49) = {\cdot}558\ 8886$.

If we compare the differences of the above results, i.e. the ratio of the area between the ordinates corresponding to x and x' to the total area, we find

I_R 1st approx. $= {\cdot}499\ 3973$,
2nd „ $= {\cdot}502\ 7983$,
3rd „ $= {\cdot}505\ 4926$,
4th „ $= {\cdot}506\ 0748$,

while the exact value $= {\cdot}503\ 0010$.

The second approximation, going up to the fourth moment, appears to give the best agreement with the Type I result; the succeeding approximations do not better the fit. On the contrary, since the terms in S_4, S_5 and S_6 are positive on one side of the mode, and negative on the other, the closer we approximate to the Romanovsky curve, the larger does the area between the two ordinates become. Whether the extra terms would change their sign eventually if we went far enough, we are not in a position to say, as we have not made the necessary computation. There seems some sign in the last approximation of an approach to an upper limit for the area measured, and we may infer thereafter a decrease. But if we did not know beforehand what our result was, there is absolutely nothing to show us at what point to stop so as to get the best result. The labour involved in producing even the results shown has been fairly strenuous, involving as it does the working out of fourteen bi-variate interpolations and the rather troublesome calculation of the S's. Enough has been done, we hope, to show that one ought to hesitate before accepting any one approximation as better than any other. The expansion is an asymptotic one and must ultimately diverge. For while the expression

$$I_1 - kI_2 + \frac{k(k-1)}{1.2} I_3 - \frac{k(k-1)(k-2)}{1.2.3} I_4 + \ldots + (-1)^k I_{k+1}$$

seems to decrease steadily as k increases, the quantities S_4, S_5, S_6 exhibit no such corresponding decrease. On the contrary they may become large, being proportional, as we have shown, to the differences between the theoretical Type III moments and the moments of the fitted distribution. For the higher moments we may expect such differences to become larger and larger.

Now the curve which we have fitted to our data is of the form

$$y = y_0'' z^a e^{-z}(b_0 + b_1 z + b_2 z^2 + \ldots) \quad \ldots\ldots\ldots\

which has only three moments the same, unless, and this is an important point, the curve (16) has negative frequencies at any point. The polynomial in z has the form

$$1+\frac{S_4}{4!\,S_0}\left(1-\frac{4z}{a+1}+\frac{6z^2}{(a+1)_2}-\frac{4z^3}{(a+1)_3}+\frac{z^4}{(a+1)_4}\right)$$
$$+\frac{S_5}{5!\,S_0}\left(1-\frac{5z}{a+1}+\frac{10z^2}{(a+1)_2}-\frac{10z^3}{(a+1)_3}+\frac{5z^4}{(a+1)_4}-\frac{z^5}{(a+1)_5}\right)+\ldots.$$

If we go up to the term in S_6 and substitute the values of our example we have for the polynomial the value

$$f(z)=\cdot285\,647+\cdot685\,678\,z-\cdot230\,583\,z^2+\cdot035\,697\,z^3-\cdot002\,740\,z^4+\cdot000\,101\,z^5-\cdot000\,001\,z^6.$$

Inspection shows that there is a root of this equation between 0 and -1 and another between 65 and 70. Now to cover the range of the Type I curve z should go from 0·533 to $\nu=\frac{5}{9}\frac{8}{3}$. Within this range, it is true, $f(z)$ is positive and therefore

$$y=y_0''\,z^a e^{-z} f(z)$$

is also positive, but just beyond it, although the ordinates are exceedingly small, they are nevertheless negative. Thus the negative frequencies when multiplied by powers of the large distances from the mean ($z=5\cdot4$) are going to affect the moments, and it becomes clear why this curve can exist, having the same first six moments as the Type I curve, and yet giving a very bad fit between two ordinates adjacent to the mode.

This would appear to render the method quite useless as a means of describing and fitting frequency distributions better than can be done at present with the aid of Professor Pearson's system of curves. The first term of the generalised expansion (13) gives a rough approximation to what we are seeking, but that is no more than we knew already, namely, that when a Type I distribution approaches, on the $\beta_1\beta_2$ diagram, the Type III line, we may get a rough idea of the frequencies by calling it Type III and fitting by means of the first three moments, and ignoring the fourth. To go even one step further, involving the calculation of five Incomplete Γ-functions, does not seem, on our experience, to give a substantially better result, commensurate with the labour involved in obtaining it. If the Romanovsky Generalised Curves are to be of value to the statistician, they must be shown to be capable of giving (a) a better fit than any other curves to statistical data, or (b) as good a fit by a speedier method, or a method susceptible of computation where existing methods are not. Now if a distribution has a β_1 and β_2 which satisfy the relation $2\beta_2-3\beta_1-6=0$ within the probable errors of the β's, the term in S_4 will be insignificant, from (10), and so an application of the generalised curve will only differ from the ordinary Type III by terms involving fifth, sixth, etc., moments which are subject to such large probable errors that the retention of terms involving them is of doubtful expediency. So we should anticipate that a Type III fit would not be bettered. On the other hand, as soon as we stray from the Type III line, the convergence of the series begins to be endangered. Our example may be considered a very favourable one, coming, as it does, so near the Type III line, and yet our results do not lead us to hope for anything as good, even, as would be obtained from fitting a Type I curve. The Probability Integrals of this Type will be obtained directly as soon as the *Tables of the Incomplete Beta-function* are published, while should the constants of the fitted curve lie outside the scope of these tables, there are various approximate formulae which we may apply in less time than it would take to work out the Romanovsky method, even up to four moments. For example, a comparatively few terms of a parts-reduction formula* would soon give us a better result, and would have this advantage, that an examination of the first term neglected would provide at once an idea of the accuracy of our result. Then again an application of the approximate method, given by Soper*, of fitting Incomplete Γ-functions at the start of the Type I curve, would give us a more dependable result: both these methods give perfectly satisfactory results, if the series be carried on long enough. This takes time, and as

* See *Tracts for Computers*, No. VII. pp. 19—20 and 40—43.

what we set out to seek was a formula speedier of computation than either, we are still as far from our goal as ever.

Quite apart, however, from this attempted application of Romanovsky's method, to which end, indeed, this investigation was carried out, his curves do not appear to better the existing types, owing to the expansion in terms of functions which are not suited to the purpose. For example, except for a small region near the point $\beta_1=0$, $\beta_2=3$ (for the Thiele-Charlier curves) and for a small area adjacent to the line $2\beta_2-3\beta_1-6=0$ (Generalised Type III) the series resulting from these expansions are not convergent, and hence cannot give us really satisfactory fits. The curve we obtained was shown to have negative frequencies over part of its range, and the same is doubtless true of similar curves obtained in analogous ways, all of which gives point to Professor Pearson's assertion* that fitting with the (Pearson) curve with the true fourth moment will give a theoretical distribution in a much more manageable form, and a better fit to the observations, than Romanovsky's curve will provide. To go beyond the fourth, and utilise higher moments, is to render the result problematical, owing to the high probable errors involved.

I am indebted to Mr J. O. Irwin for aid in checking the rather laborious arithmetic of this paper.

II. On The Linear Correlation Ratio in the case of Certain Symmetrical Frequency Distributions.

By J. R. MUSSELMAN, Ph.D., Johns Hopkins University.

Professor Pearson has developed a linear correlation ratio†, on the assumption of a normal frequency surface, which is of use when one of the characters is in broad categories. It is the object of this article to extend his linear correlation ratio to the frequency surface, with linear regression, for which the β_1's in the case of both marginal totals are zero, and the β_2's are equal but arbitrary.

The equation of this surface‡ can be written as

$$Z=\frac{N}{2\pi\sigma_1\sigma_2}\frac{1}{\sqrt{1-r^2}}\frac{n-1}{n-2}\frac{1}{\left\{1+\frac{1}{2(n-2)}\frac{1}{1-r^2}\left(\frac{x^2}{\sigma_1^2}-2r\frac{xy}{\sigma_1\sigma_2}+\frac{y^2}{\sigma_2^2}\right)\right\}^n},$$

where $\beta_2>3$; and the marginal totals are given by

$$\phi_1(x)=\frac{N}{\sqrt{2\pi}\,\sigma_1}\frac{1}{\sqrt{n-2}}\frac{\Gamma(n-\frac{1}{2})}{\Gamma(n-1)}\frac{1}{\left(1+\frac{1}{2(n-2)}\frac{x^2}{\sigma_1^2}\right)^{n-\frac{1}{2}}},$$

where

$$n=\frac{3(\beta_2-2)}{\beta_2-3}.$$

The linear correlation ratio is

$$\zeta_{y,x}=\sum_{x>\bar{x}}\frac{n_x(\bar{y}_x-\bar{y})}{N\sigma_2}+\sum_{x<\bar{x}}\frac{n_x(\bar{y}-\bar{y}_x)}{N\sigma_2}.$$

Calling the first half of this expression $\zeta'_{y,x}$, and the second half $\zeta''_{y,x}$, we have

$$\left.\begin{aligned}\zeta'_{y,x}&=\sum_{x>\bar{x}}\frac{n_x(\bar{y}_x-\bar{y})}{N\sigma_2}=\frac{\int_{\bar{x}}^{\infty}(\bar{y}_x-\bar{y})\,\phi_1(x)\,dx}{N\sigma_2}\\ \text{and}\quad\zeta''_{y,x}&=\sum_{x<\bar{x}}\frac{n_x(\bar{y}-\bar{y}_x)}{N\sigma_2}=\frac{\int_{-\infty}^{\bar{x}}(\bar{y}-\bar{y}_x)\,\phi_1(x)\,dx}{N\sigma_2}\end{aligned}\right\}\quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

* See Note on Prof. Romanovsky's paper, *Biometrika*, Vol. xvi. p. 116.

† Pearson, *Biometrika*, Vol. xvii. pp. 459—461.

‡ Pearson, *Biometrika*, Vol. xv. p. 234 *et seq.*

Since this surface has linear regression and is referred to its mean as origin

$$\bar{y}_x - \bar{y} = r\frac{\sigma_2}{\sigma_1}x.$$

Substituting this in (1) we have

$$\left.\begin{aligned}\zeta'_{y,x} &= \frac{r}{N\sigma_1}\int_0^\infty x\phi_1(x)\,dx \\ &= \frac{r\,\Gamma(n-\frac{1}{2})}{\sqrt{2\pi}\,\sigma_1{}^2(n-2)^{\frac{1}{2}}\,\Gamma(n-1)}\int_0^\infty \frac{x\,dx}{\left(1+\frac{x^2}{2(n-2)\,\sigma_1{}^2}\right)^{n-\frac{1}{2}}} \\ &= \frac{r\,(n-2)^{\frac{1}{2}}}{\sqrt{2\pi}\,(n-\frac{3}{2})}\,\frac{\Gamma(n-\frac{1}{2})}{\Gamma(n-1)}\end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots (2).$$

It is readily seen that $\zeta''_{y,x} = \zeta'_{y,x}$ and hence, solving for r,

$$\zeta_{y,x} = \sqrt{\frac{\pi}{2}}\,\frac{n-\frac{3}{2}}{(n-2)^{\frac{1}{2}}}\,\frac{\Gamma(n-1)}{\Gamma(n-\frac{1}{2})}\left\{\sum_{x>\bar{x}}^{+}\frac{n_x(\bar{y}_x-\bar{y})}{N\sigma_2}+\sum_{x<\bar{x}}^{+}\frac{n_x(\bar{y}-\bar{y}_x)}{N\sigma_2}\right\} \quad \ldots\ldots\ldots\ldots\ldots (3).$$

In the use of this formula $\bar{x}$ will fall somewhere, generally, inside one group of the broad categories. As the formula is valid only when $x > \bar{x}$ and $x < \bar{x}$ we must divide up this group. Calling the frequencies on each side of the mean in this group n_1, n_2; with values x_1 and x_2 at the ends of the group interval and $\bar{y}_1$, $\bar{y}_2$ the y means and $\bar{x}_1$, $\bar{x}_2$ their abscissae, we have, since the regression is linear,

$$\frac{\bar{y}_2-\bar{y}}{\sigma_2}\,\frac{n_2}{N} = \frac{r\,(\bar{x}_2-\bar{x})}{\sigma_1}\,\frac{n_2}{N} = r\,(t_0-t_2),$$

$$\frac{\bar{y}-\bar{y}_1}{\sigma_2}\,\frac{n_1}{N} = \frac{r\,(\bar{x}-\bar{x}_1)}{\sigma_1}\,\frac{n_1}{N} = r\,(t_0-t_1),$$

where

$$\left.\begin{aligned} t_0 &= \frac{1}{\sqrt{2\pi}}\,\frac{(n-2)^{\frac{1}{2}}}{n-\frac{3}{2}}\,\frac{\Gamma(n-\frac{1}{2})}{\Gamma(n-1)} \\ t_1 &= \frac{1}{\sqrt{2\pi}}\,\frac{(n-2)^{\frac{1}{2}}}{n-\frac{3}{2}}\,\frac{\Gamma(n-\frac{1}{2})}{\Gamma(n-1)}\,\frac{1}{\left\{1+\frac{x_1{}^2}{2(n-2)\,\sigma_1{}^2}\right\}^{n-\frac{3}{2}}} \\ t_2 &= \frac{1}{\sqrt{2\pi}}\,\frac{(n-2)^{\frac{1}{2}}}{n-\frac{3}{2}}\,\frac{\Gamma(n-\frac{1}{2})}{\Gamma(n-1)}\,\frac{1}{\left\{1+\frac{x_2{}^2}{2(n-2)\,\sigma_1{}^2}\right\}^{n-\frac{3}{2}}} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots (4).$$

Hence writing $\zeta_{y,x} = r$:

$$r = \sqrt{\frac{\pi}{2}}\,\frac{n-\frac{3}{2}}{(n-2)^{\frac{1}{2}}}\,\frac{\Gamma(n-1)}{\Gamma(n-\frac{1}{2})}\left[\left\{\sum_{x>\bar{x}}^{+}\frac{n_x(\bar{y}_x-\bar{y})}{N\sigma_2}+\sum_{x<\bar{x}}^{+}\frac{n_x(\bar{y}-\bar{y}_x)}{N\sigma_2}\right\}+r\,(2t_0-t_1-t_2)\right] \quad \ldots\ldots (5),$$

omitting median array, or

$$r = \left\{\sum_{x>\bar{x}}^{+}\frac{n_x(\bar{y}_x-\bar{y})}{N\sigma_2}+\sum_{x<\bar{x}}^{+}\frac{n_x(\bar{y}-\bar{y}_x)}{N\sigma_2}\right\}\left(\frac{1}{t_1+t_2}\right) \quad \ldots\ldots\ldots\ldots\ldots (6),$$

omitting median array.

Formula (6) then gives the exact value of r, if the distribution of the character in broad categories follows the type of curve $\phi_1(x)$.

To use it, the constants of the curve $\phi_1(x)$ must be calculated from the distribution, whence t_1 and t_2 are readily found and the formula (6) can be used. This involves more computation than in the case of the normal frequency surface for which tables of the ordinates are available. Let us see how much error will be caused by using the normal z_1 and z_2 in the formula (6) instead of t_1 and t_2. The following table is calculated for the curve $\phi_1(x)$ at $\frac{x}{\sigma} = \cdot 5$ for various values of β_2.

We must then calculate the area from the mean to $\frac{x}{\sigma}=\cdot5$ for each curve and ascertain the value of the ordinate of the normal curve which has the same area.

β_2	n	t_2	Area*	z_2	z_2/t_2
3·03+	100	·35142	·19208	·35176	1·0010
3·06+	50	·35075+	·19272	·35143	1·0019
3·1	33	·35003	·19340	·35109	1·0030
3·2	18	·34814	·19519	·35018	1·0059
3·3	13	·34637	·19685+	·34933	1·0085+
3·4	10·5	·34472	·19840	·34853	1·0110
3·5	9	·34317	·19983	·34778	1·0134
3·6	8	·34172	·20112	·34707	1·0157
3·8	6·75	·33906	·20362	·34578	1·0198
4·0	6	·33669	·20578	·34461	1·0235+
4·5	5	·33178	·21021	·34218	1·0313

When $\beta_2<3$ the equation of the surface† is

$$Z=\frac{N}{2\pi\sigma_1\sigma_2}\frac{1}{\sqrt{1-r^2}}\frac{n+1}{n+2}\left\{1-\frac{1}{2(n+2)}\frac{1}{1-r^2}\left(\frac{x^2}{\sigma_1^2}-2r\frac{xy}{\sigma_1\sigma_2}+\frac{y^2}{\sigma_2^2}\right)\right\}^n,$$

and

$$\phi_1(x)=\frac{N}{\sqrt{2\pi}\sigma_1}\frac{1}{(n+2)^{\frac{1}{2}}}\frac{\Gamma(n+2)}{\Gamma(n+\frac{3}{2})}\left(1-\frac{x^2}{2(n+2)\sigma_1^2}\right)^{n+\frac{1}{2}},$$

where

$$n=\frac{3(\beta_2-2)}{3-\beta_2}.$$

Proceeding as before,

$$\zeta'_{y,x}=\int\frac{(\bar{y}_x-\bar{y})}{N\sigma_2}\phi_1(x)\,dx=\frac{r}{N\sigma_1}\int_0^a x\phi_1(x)\,dx$$

$$=\frac{r}{\sqrt{2\pi}\sigma_1^2}\frac{\Gamma(n+2)}{\Gamma(n+\frac{3}{2})}\frac{1}{(n+2)^{\frac{1}{2}}}\int_0^a x\left(1-\frac{x^2}{2(n+2)\sigma_1^2}\right)^{n+\frac{1}{2}}dx$$

$$=\frac{r(n+2)^{\frac{1}{2}}}{\sqrt{2\pi}(n+\frac{3}{2})}\frac{\Gamma(n+2)}{\Gamma(n+\frac{3}{2})}.$$

As $\zeta''_{y,x}=\zeta'_{y,x}$, then if we put $\zeta_{y,x}=r$, we have

$$r=\sqrt{\frac{\pi}{2}}\frac{n+\frac{3}{2}}{(n+2)^{\frac{1}{2}}}\frac{\Gamma(n+\frac{3}{2})}{\Gamma(n+2)}\left\{\Sigma_{+}{}_{x>\bar{x}}\frac{n_x(\bar{y}_x-\bar{y})}{N\sigma_2}+\Sigma_{+}{}_{x<\bar{x}}\frac{n_x(\bar{y}-\bar{y}_x)}{N\sigma_2}\right\}.$$

Similarly we can derive that

$$r=\left\{\Sigma_{+}{}_{x>\bar{x}}\frac{n_x(\bar{y}_x-\bar{y})}{N\sigma_2}+\Sigma_{+}{}_{x<\bar{x}}\frac{n_x(\bar{y}-\bar{y}_x)}{N\sigma_2}\right\}\left(\frac{1}{t_1+t_2}\right) \quad \text{.....(7),}$$

omitting median array,

where

$$t_1=\frac{1}{\sqrt{2\pi}}\frac{(n+2)^{\frac{1}{2}}}{(n+\frac{3}{2})}\frac{\Gamma(n+2)}{\Gamma(n+\frac{3}{2})}\left(1-\frac{x_1^2}{2(n+2)\sigma_1^2}\right)^{n+\frac{3}{2}}$$

and

$$t_2=\frac{1}{\sqrt{2\pi}}\frac{(n+2)^{\frac{1}{2}}}{(n+\frac{3}{2})}\frac{\Gamma(n+2)}{\Gamma(n+\frac{3}{2})}\left(1-\frac{x_2^2}{2(n+2)\sigma_1^2}\right)^{n+\frac{3}{2}}.$$

* The areas were computed to five place accuracy by use of manuscript tables in the Biometric Laboratory of the incomplete Beta-function where available; in other cases by the method of Wishart, *Biometrika*, Vol. XVII. p. 469.

† Pearson, *Biometrika*, Vol. XV. p. 240.

If we substitute z_1 and z_2 the ordinates of the normal curve in formula (7) for t_1 and t_2 we shall introduce a certain amount of error. The following table is calculated for the above curve $\phi_1(x)$ at $\frac{x}{\sigma}=\cdot5$ for the given values of β_2.

β_2	n	t_2	Area	z_2	z_2/t_2
2·94	47	·35333	·19022	·35268	·99816
2·9	27	·35425+	·18936	·35311	·99678
2·8	12	·35662	·18674	·35439	·99375−
2·7	7	·35918	·18457	·35545	·98962
2·6	4·5	·36195+	·18172	·35680	·98577
2·5	3	·36498	·17879	·35818	·98137
2·4	2	·36828	·17540	·35973	·97678
2·2	0·75	·37591	·16753	·36323	·96627
2·0	0	·38525+	·15748	·36744	·95377
1·8	−0·5	·39693	·14434	·37253	·93853
1·5	−1	·42108	·11503	·38224	·90776

Conclusion. If the distribution in broad categories follows the curve for which $\beta_1=0$, equations (6) and (7) will give the exact values of the linear correlation ratio. If instead of using them, we use the assumption of a normal curve, the two tables give the error at $\frac{x}{\sigma}=\cdot5$, which generally covers the middle group in the distribution. For β_2 lying between 2·4 and 4·0 the error is approximately two per cent., and this is within the usual range of statistical error. Hence it seems justifiable to use the assumption of normal distribution, if our marginal total is such that $\beta_1=0$ and $2\cdot4<\beta_2<4$.

III. On the Avuncular Relationship.

By KARL PEARSON.

If the correlation between pairs of relations be linear, and if the individual ancestral correlations decrease in geometrical progression—hypotheses satisfied by the simple Mendelian theory whether of gametic or somatic constitutions—then the multiple regression equation ("Law of Ancestral Heredity"), and all the collateral correlations can be deduced from a knowledge of three constants, namely:

(i) the coefficient, ϵ, of assortative mating supposed constant for all generations,

(ii) the mean correlation ρ_1 of parent and offspring, and

(iii) the mean fraternal correlation r, which is equal to R^2, where R is the multiple correlation of offspring on all ancestry*.

Using the notation of the paper just referred to, in particular, $c_p=\gamma\eta^p=p$th coefficient in multiple regression formula; $r_{p-q}=$correlation coefficient of pth and qth midparents; $\rho_p=$mean correlation coefficient of individual pth ancestor and offspring, we find for r_{cc} the correlation of cousins and for r_{un} the correlation of uncle (or aunt) with nephew (or niece) the following values†:

$$r_{cc}=\frac{1}{2}r-\frac{1}{2}\gamma^2\eta^2\left(1-\frac{r}{1+\epsilon}\right),$$

$$r_{un}=\frac{1}{\sqrt{2}}\frac{\gamma\eta}{1-\eta^2}(\gamma\eta^2+(1+\eta^2)r).$$

Taking stature for males we find

$$\rho_1=\cdot5040,\quad \epsilon=\cdot2804,\quad \rho_1'=\cdot393{,}627,\quad \sqrt{2}\rho_1'=\cdot556{,}673,\quad r=\cdot5196.$$

* *Biometrika*, Vol. XVII. p. 131. See also p. 134.

† Algebraical proofs to be published later.

Hence, since $$\beta = \sqrt{2}\rho_1' + \sqrt{(1-r)\left(1-\frac{2\rho_1'^2}{r}\right)}$$
$$= \cdot 997{,}006.$$

Again $$\eta = \frac{\beta - \sqrt{2}\rho_1'}{1-r} = \cdot 916{,}596,$$
$$\gamma\eta = \beta - \eta = \cdot 080{,}410.$$

Thus we find $$r_{ee} = \cdot 2579, \quad r_{un} = \cdot 3686.$$

These would be the values of cousin and uncle correlations for stature.

If we take the extreme case for $\beta = 1$, $\gamma\eta = 1-\eta$, and accordingly

$$r_{ee} = \frac{1}{2}r - \frac{1}{2}(1-\eta^2)\left(1 - \frac{r}{1+\epsilon}\right),$$

$$r_{un} = \frac{1}{\sqrt{2}}\frac{1}{1+\eta}(\eta(1-\eta) + (1+\eta^2)r),$$

then the quadratic for η shows that as β approaches unity so does η, or we have

$$r_{ee} = \frac{1}{2}r, \quad r_{un} = \frac{1}{\sqrt{2}}r.$$

For twelve measured characters, $r = \cdot 5250$ in the mean, hence

$$r_{ee} = \cdot 2625, \quad r_{un} = \cdot 3712,$$

no great difference from the previous values for stature.

It is clear from these results that we might anticipate that cousins would be about half as closely related as brothers and uncle and nephew about 40 °/₀ more closely than cousins.

In 1907 Miss E. M. Elderton prepared 70 correlation tables for quantitative and qualitative characters in cousins and found an average value of ·265, a value in accordance with the above theory. But in 1907 she also worked out 56 tables for qualitative characters for uncles, aunts, nephews and nieces. The result was a mean correlation of ·2384 slightly less than for cousins, but explicable if allowance be made for difference of generation. The data were chiefly taken from my schedules of family record.

Dr Snow working by Mendelian theory* found a near equality between the correlations for the cousinal and avuncular relations. Notwithstanding Dr Snow's apparent theoretical corroboration of Miss Elderton's observed values, the point has always seemed to me an obscure one, and one demanding further investigation. Sir Francis Galton would not hear of the avuncular and cousinal correlations being equal. He wrote to me on Oct. 30, 1907:

"There is one serious difficulty in the conclusion, namely that the relation between a person and his uncle is the same as that between that person and his uncle's child. This cannot be the case unless the wife of the uncle is a counterpart of himself."

Dr Snow's result for Mendelism seemed to indicate that the equality of r_{ee} and r_{un} might be possible, but Sir Francis was very strong on the point, and the avuncular correlation tables have remained nearly twenty years unpublished. Recently I reached in lecture the above results for r_{ee} and r_{un} confirming Galton's point that the avuncular relationship was closer than that of cousins. Hence either there is some error in my recent work, or Galton is right and there is a slip in Dr Snow's work, and further my family records which give reasonable values for cousinships are not to be depended on for the avuncular relationships. The determination for a measurable character of the correlation of uncle and nephew would be of very great value.

* *R. S. Proc.* Vol. LXXXIII. B. pp. 48—53, 1911.

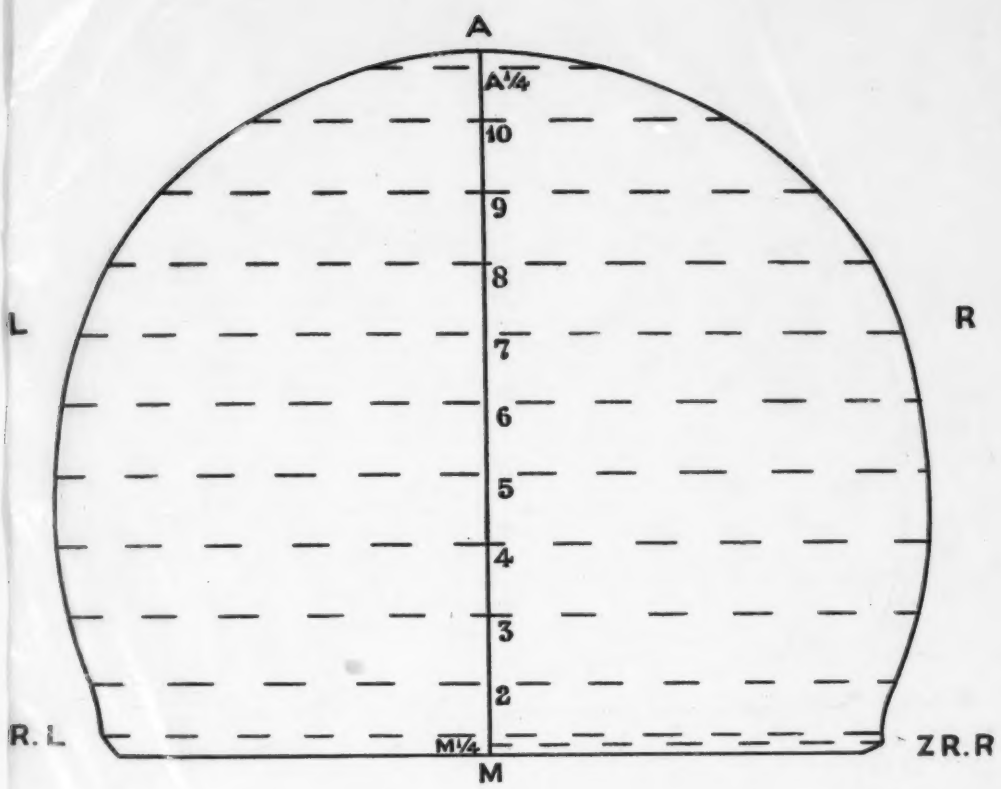


FIG. I 17th Century Londoners ♂ Transverse Type Contour.

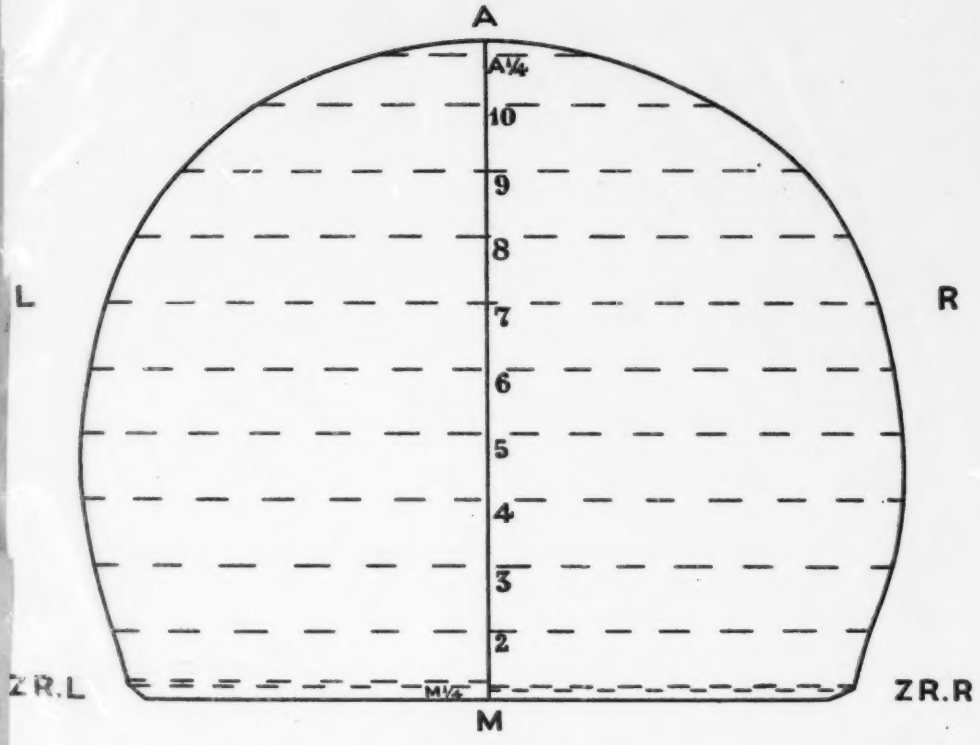


FIG. II 17th Century Londoners ♀ Transverse Type Contour.

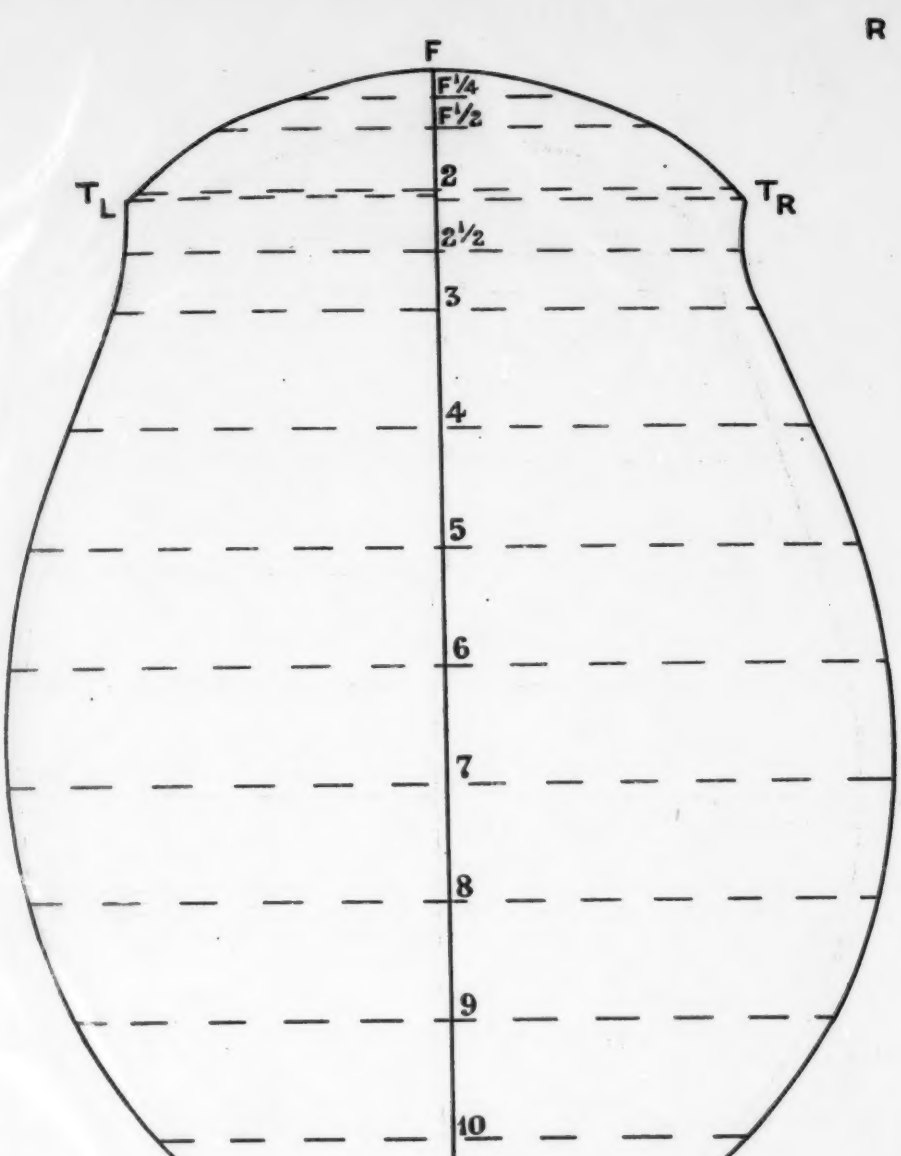


FIG. III. 17th Century Londoners ♂ Horizontal Type Contour.

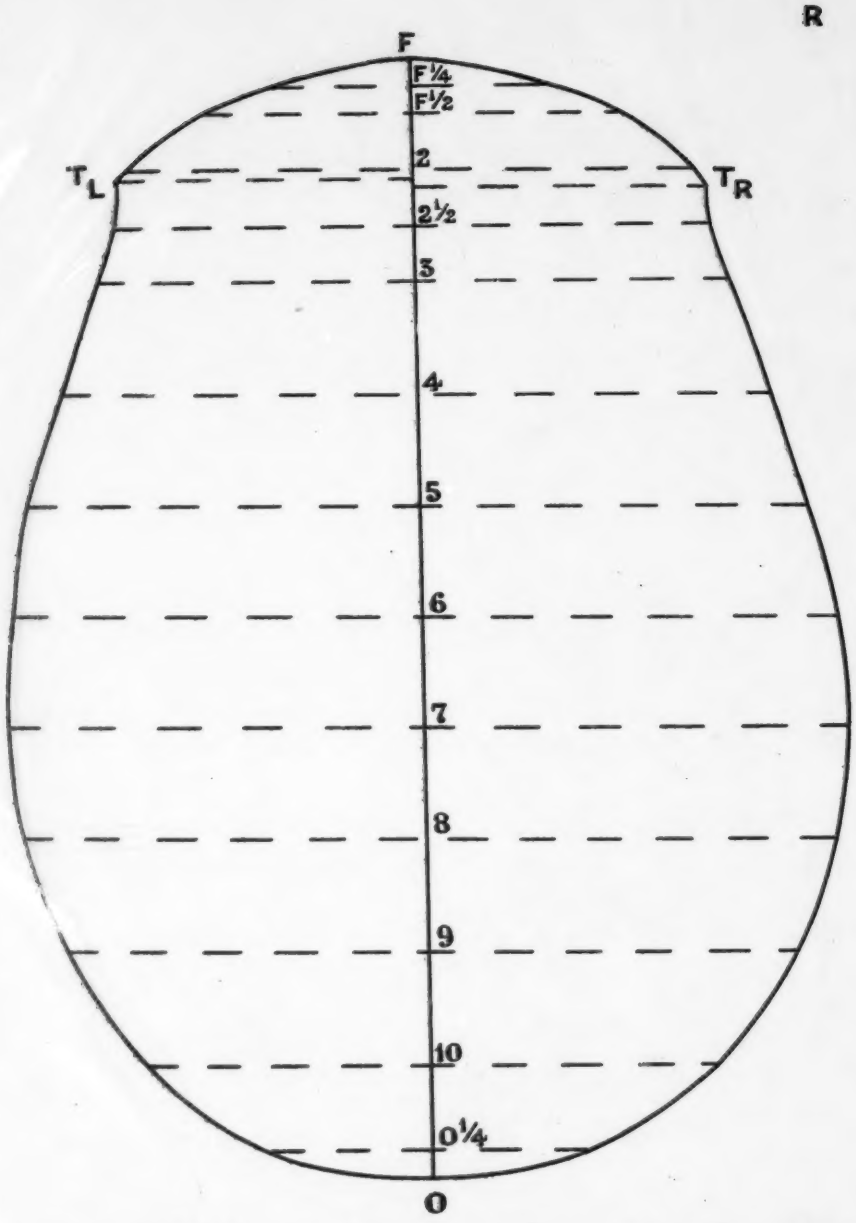


Fig. IV 17th Century Londoners ♀ Horizontal Type Contour.

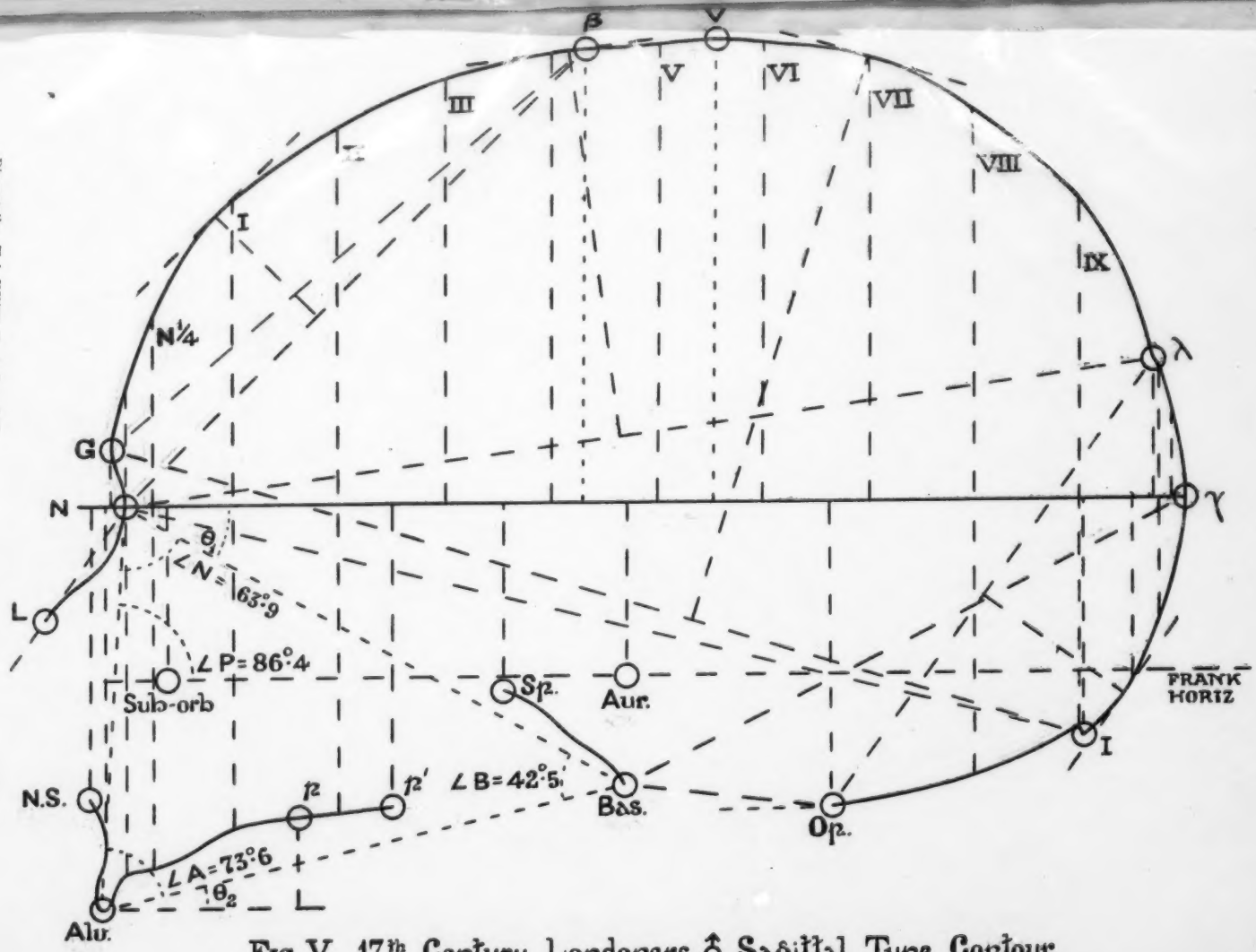


FIG. V 17th Century Londoners ♂ Sagittal Type Contour.

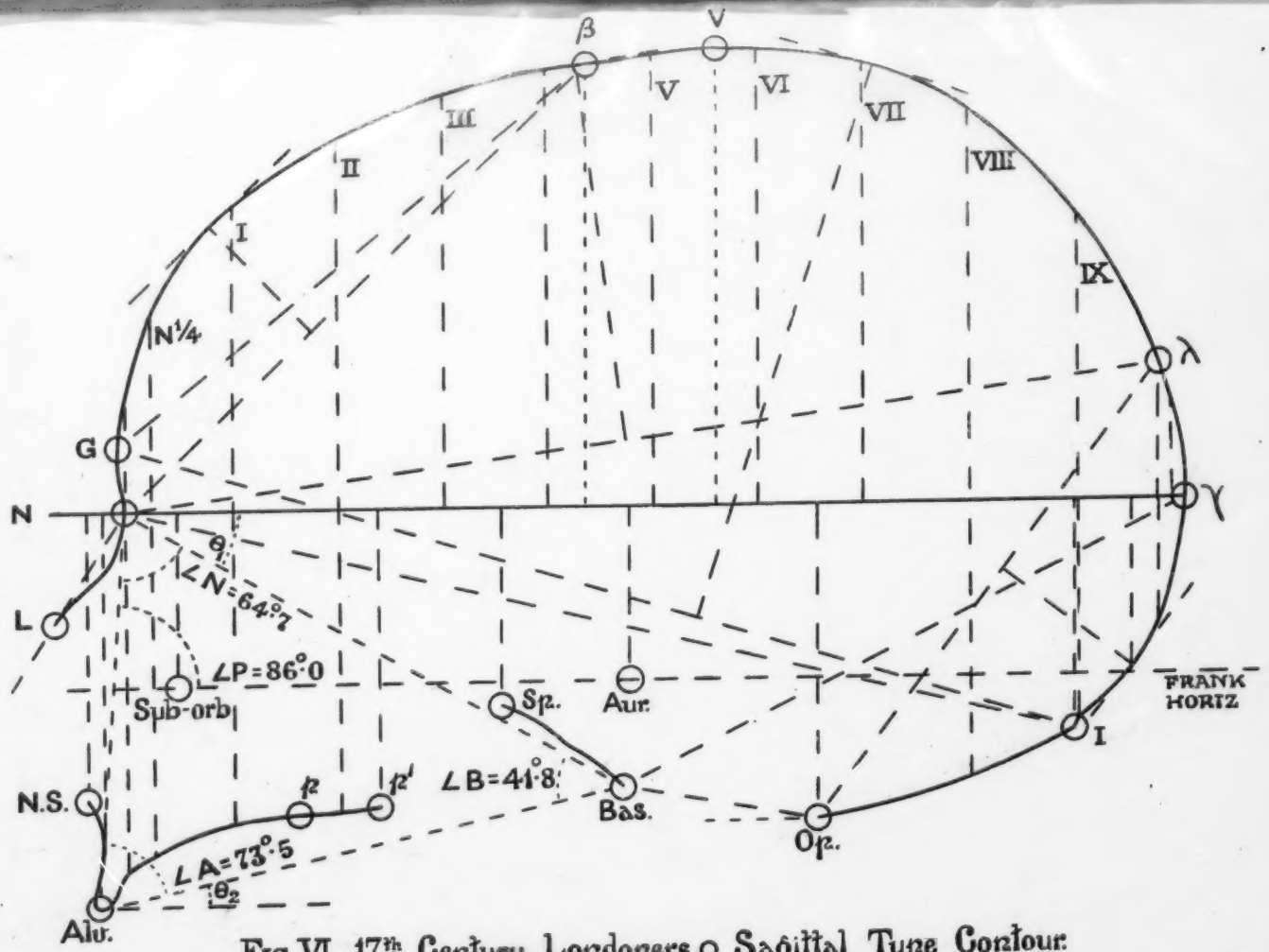


FIG. VI 17th Century Londoners ♀ Sagittal Type Contour

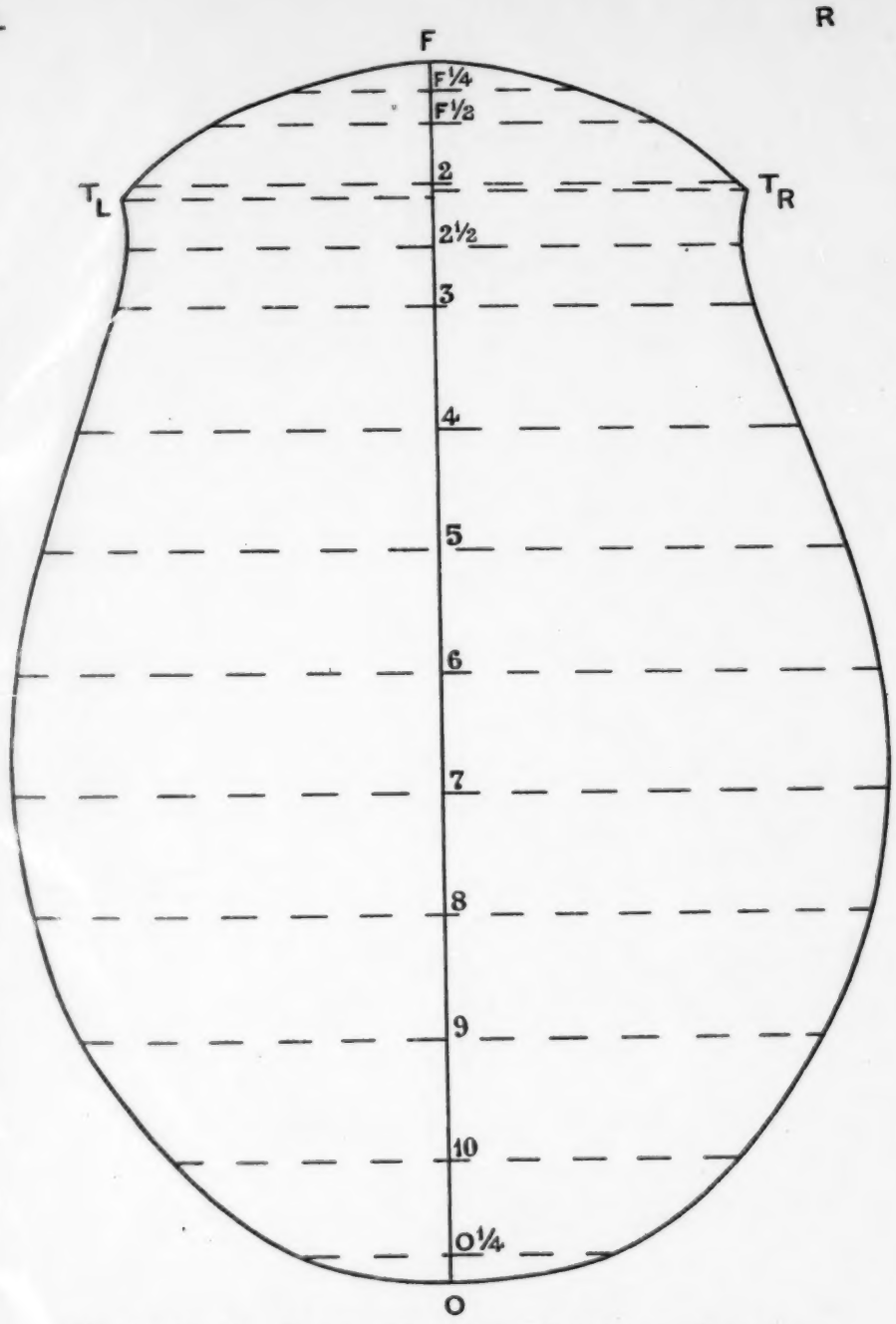


FIG. I Anglo-Saxon ♂ Horizontal Type Contour.

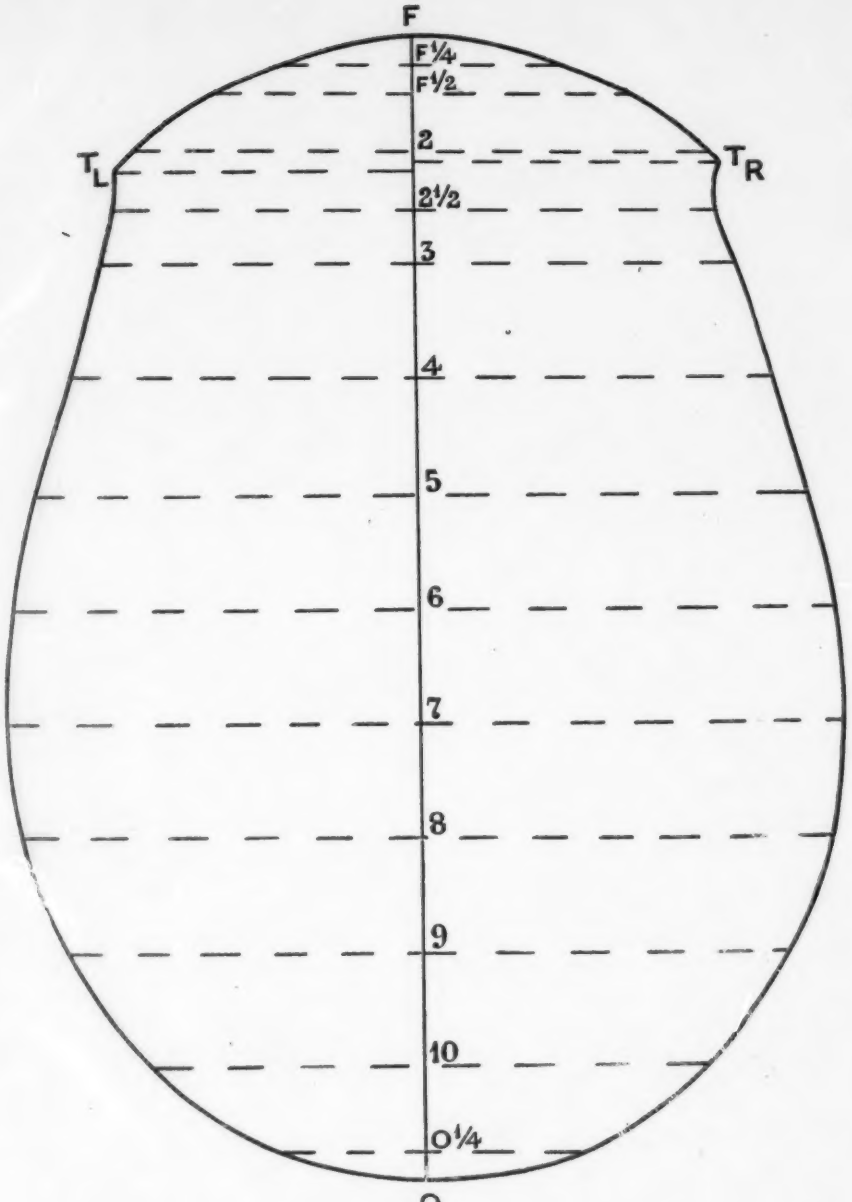


FIG. II Anglo-Saxon ♀ Horizontal Type Contour.

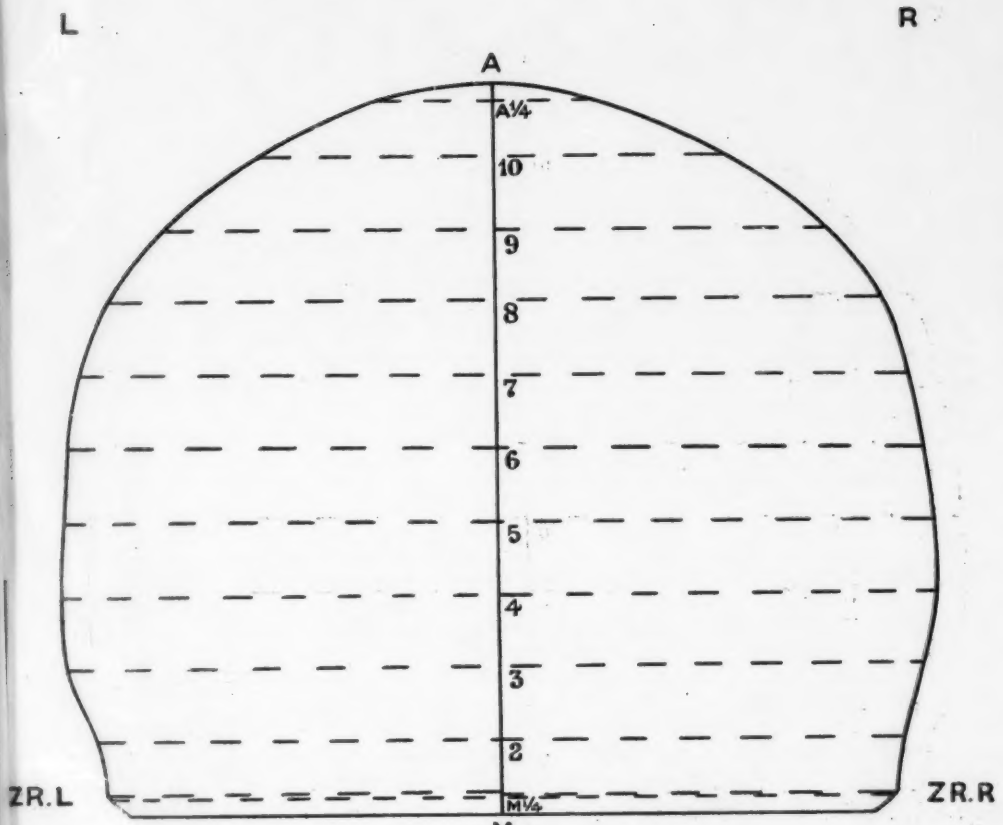


FIG. III Anglo-Saxon ♂ Transverse Type Contour.

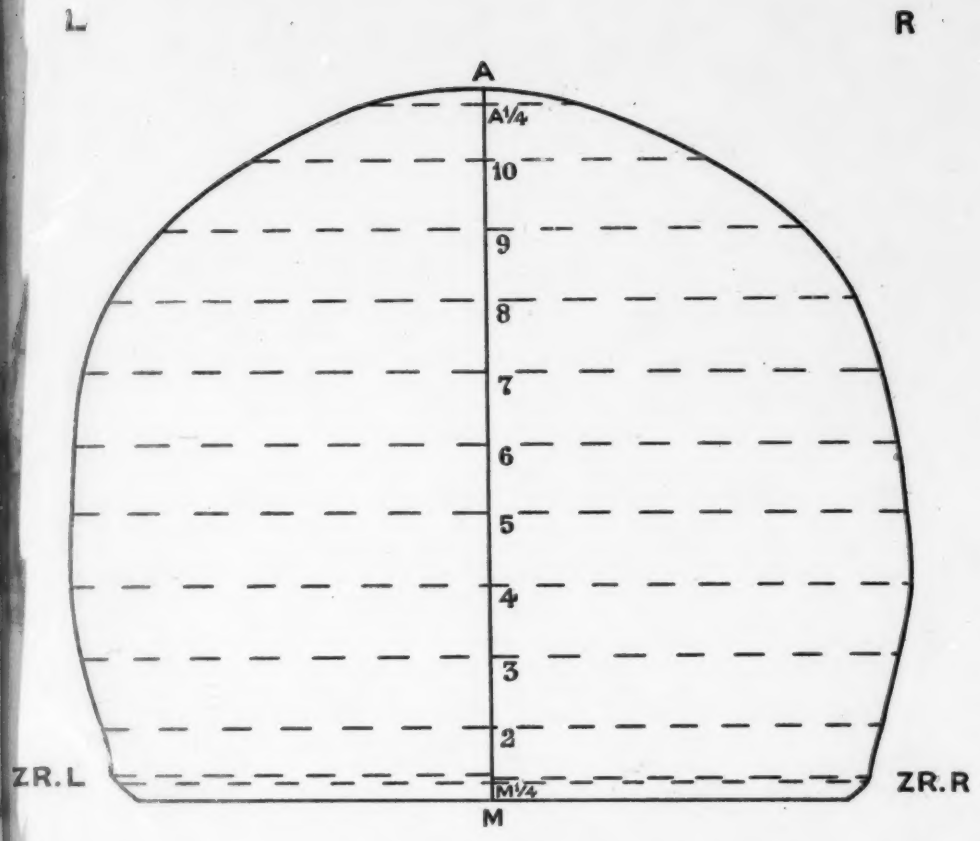


FIG IV Anglo-Saxon ♀ Transverse Type Contour

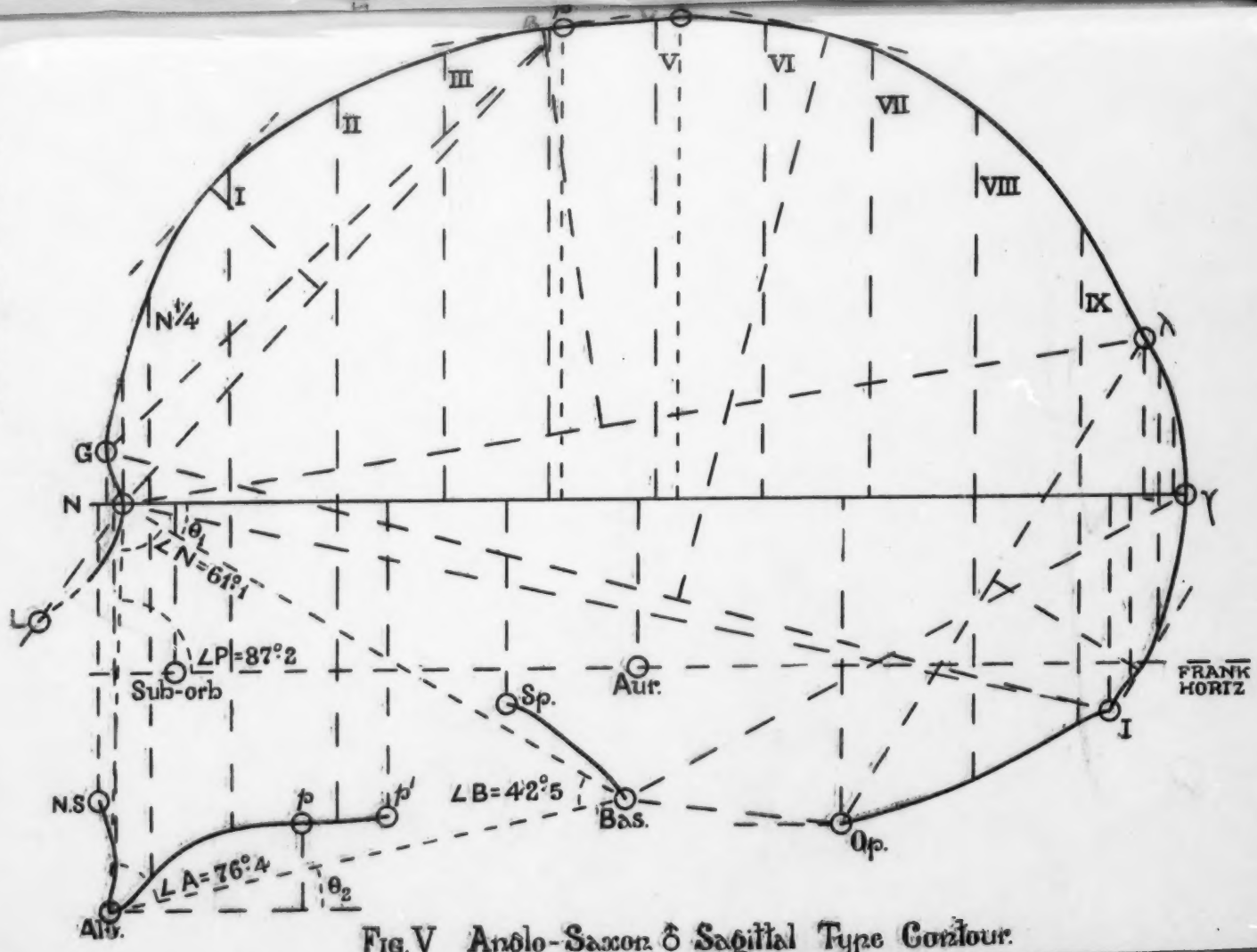


FIG. V Anglo-Saxon ♂ Sagittal Type Contour.

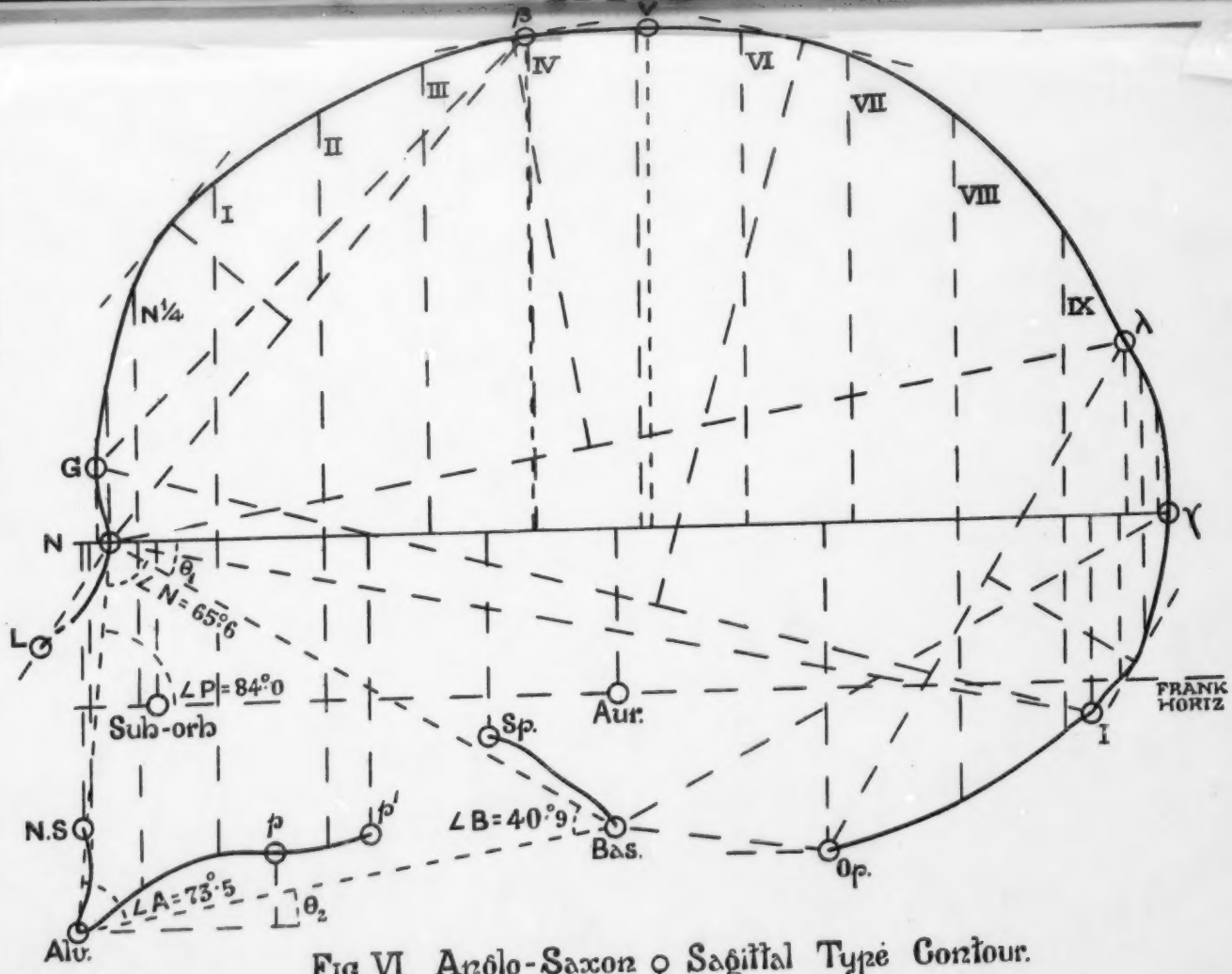


FIG. VI Anglo-Saxon ♀ Sagittal Type Contour.